CAE IN CYBERSECURITY COMMUNITY

NATIONAL CRYPTOLOGIC FOUNDATION

# 2020 NCAE-C HIGH SCHOOL DESIGNATION FEASIBILITY STUDY

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Moraine Valley Community College

DARK ENTERPRISES, INC

Funding support for the 2020 NCAE-C High School Designation Feasability Study provided by the National Centers of Academic Excellence in Cybersecurity grant (H98230-20-1-0292) Subaward: SA20137, which is part of the National Security Agency

# Table of Contents

# REPORT OF FINDINGS

# Acknowledgement

The 2020 National Centers of Academic Excellence in Cybersecurity, California State University, San Bernardino, High School Study would not be possible without the significant efforts of the National Cryptologic Foundation's (NCF) Strategic Partners, Dark Enterprises, INC, University of Alabama Huntsville, and Moraine Valley Community College, and their outstanding teams. NCF wishes to thank Melissa Dark, Jenny Daugherty, Tania Williams, and John Sands for their insight, leadership, and dedication to this project.

In addition, NCF thanks the many team members from our partners; Nancy Stevens, Chris Lannin, Jacqueline Allen-Magers, Sabrina Smiley, Evans and Boersma Cybersecurity LLC, Portia Pusey, Sandra Leiterman, Michael Gonzalez, Anna Rodgers, Bethany Belue, Pamela MacDonald, Destiny Howdyshell, and Andrea Graham. Due to the efforts of everyone involved, the Centers of Academic Excellence in Cybersecurity Community now has statistically significant empirical data concerning cybersecurity in high schools were before we relied on antidotal impressions. The NCF is grateful to the team for all the work accomplished under this grant.

# Introduction

The ***2020 NCAE CSUSB – High School Study, (H98230-20-1-0292, SA20137)*** investigated the practicality of a High School Cybersecurity Recognition Program. The study objectively and rationally uncovered the strengths and weaknesses of establishing a HS program, opportunities and threats, the resources required to implement, and ultimately, the prospects for success. The study assessed feasibility regarding whether a HS program can be developed and implemented based on cost and value to be attained and made recommendations as to its advisability, i.e., should it be developed and implemented.

This complex study was guided by a Theory of Change methodology and broken down by a research design splitting tasks into five teams. Utilizing the educational expertise of Dark Enterprise, University of AL, Huntsville, and Moraine Valley College, NCF held monthly virtual meetings and several on-site team meetings to discuss findings. As one would expect, differences of opinions developed over the two year study. This is good and healthy for a first look at cybersecurity recognition at the HS level. Data at times was hard to collect and inconsistencies at the State level were not surprising.

However, you will find quality empirical data detailed in the five Appendices attached to this summary. We no longer need to depend on generalized anecdotal rhetoric. We now have statistically significant data from which to base informed decisions. These appendices are unchanged from the individual teams with no attempt to normalize across the five. This was purposefully done so the reader has clear insight into the findings of each team. We feel this is a first look and additional research is required.

In true “Bottom Line Up Front” fashion, the team as a whole agrees that today HS cybersecurity programs are not ready for a formal national recognition program (no matter what it is called) in a similar manner as the college based National Centers of Academic Excellence in Cybersecurity (NCAE-C). However, you will discover throughout this summary and in the Appendices, glimmers of limited feasibility to recognize HS cybersecurity programs that are succeeding. You will discover the restricted advisability to invest government resources to create a program at this time as it may have limited return on investment.

However, doing so might create an initial target for programs to strive toward. Several suggestions are offered for possible ways forward. The team agrees that caution be used prior to initiating a program and additional research and data is required.

# Theoretical Framework

A Theory of Change methodology was used to guide the study. Theory of change work has been called "identifying the missing middle" in describing how change did happen, is happening, or *is supposed to happen*. Most organizations and programs operate from a theory of change. However, the theory of change is often not well-reasoned or explicitly stated. Done well, theory of change critically examines ideas and assumptions, and in the process often reveals biases and inadequacies so they can be mitigated. Theory of change is termed a 'theory' because development pathways are complicated and co-adaptive, making change difficult to predict.

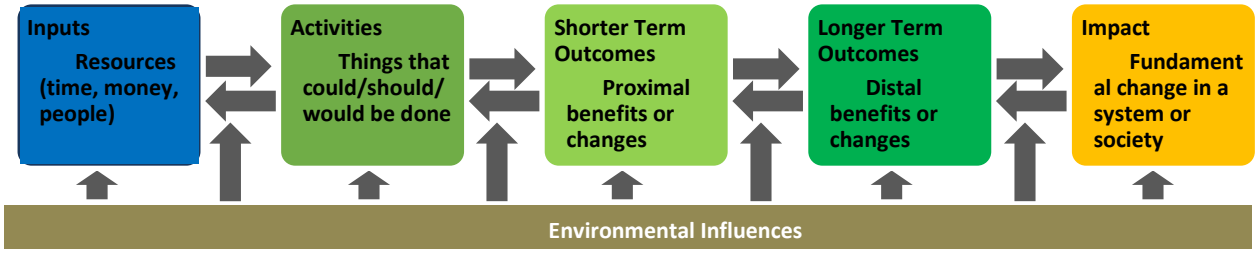



***Figure 1.*** Theory of Change methodology

The theory of change model was used to first identify the intended impact and outcomes that are supposed to happen if a High School Cybersecurity Recognition were created.

**Impact**

The intended impact of a High School Cybersecurity Recognition Program is to expand the cybersecurity workforce by developing new pathways that get more students into cybersecurity careers.

## Outcomes

In order to have this impact, the following longer- and shorter-term outcomes would be necessary.

- Longer term, a considerable number of high schools in the United States need to provide cybersecurity courses and out of school time (OST) cybersecurity activities (such as clubs and competitions).
- In order to have a considerable number of high schools in the U.S. providing cybersecurity courses and OST cybersecurity activities, shorter term we need: 1) foundations on which to build and 2) knowledge. These foundations include curriculum, instruction, and assessment and a sufficient number of qualified teachers to teach.

### Activities

Activities are planned and implemented actions that lead to outcomes. Assuming the outcomes above are appropriate and sufficient, our team considered the activities necessary to produce the desired outcomes.

- Curriculum and instructional materials related activities
- Activities to address classroom and instructional requirements
- Assessment and student readiness activities
- Teacher development and staffing activities

The question at hand is whether a program to recognize outstanding high school education is a needed activity to enable desired outcomes. And if so, what attributes would it need to have to have the anticipated effect. If a recognition program was an environmental influence on the activities occurring in schools, what outcomes should it lead to, how would it interact with other activities to produce the desired outcomes, and what anticipated quantitative and qualitative effects would it have on growing the cybersecurity workforce?

# Research Design

In answering these larger questions, the research team investigated eight aspects including: acceptability, integration, implementation, utilization, sustainability, costs and benefits, practicality, and finally, feasibility.

To answer these questions, the team had five research projects (with accompanying reports provided in the Appendices) as follows:

1. Initial Focus Groups
2. Criteria for Recognition Study
3. Landscape Study of Existing HS Cybersecurity
4. Benchmarking Other Recognition Programs
5. Case Studies of Existing Leading HS Cybersecurity Programs

| Research Area | Initial Focus Groups | Criteria for Recognition Study | Landscape Study of Existing HS Cybersecurity | Benchmarking Other Recognition Programs | Case Studies of Existing Leading HS Cybersecurity Programs |
|---|---|---|---|---|---|
| **Acceptability** | X | X | | | |
| **Integration** | X | X | X | | |
| **Implementation** | X | | X | X | X |
| **Utilization** | | | X | | X |
| **Sustainability** | | | | | X |

***Table 1.*** Research project alignment to research questions.

# Findings

Several of the findings across the five research projects speak to the required inputs to the theory of change model described above. They also speak to some of the challenges and roadblocks to effectively engaging in the activities that are targeting the desired outcomes. Each aspect of the larger research questions has smaller questions that were addressed via data collected in the research projects.

## Acceptability

### How will a High School Cybersecurity Recognition program be received in the high school education sector?

Based on the initial focus groups and the Criteria for Recognition focus groups (See Appendix A and B for the detailed findings of these two research studies), the high school education sector will receive a High School Cybersecurity Recognition program favorably. However, the value proposition needs to be clear and compelling by:

- Programs of study standards
- Establishing a community of practice
- Develop clear, fair, and inclusive benchmarks

In addition, focus group respondents stressed that if a recognition program were in existence, while it needs to develop and hold schools accountable to standards, it would also need to help schools navigate multiple environmental factors (enablers and barriers discussed more fully in the report) impacting the creation and growth of cybersecurity programs and pathways.

### What achievements should be recognized?

The focus of the Criteria for Recognition focus groups was on determining a set of criteria to model a 5 star recognition program across 6 categories and achievements. A rubric was developed based on input from the initial focus groups that includes 5 levels that are denoted as stars where one star reflects a program at the entry level of building a cybersecurity program and five stars comprises an “exemplary” high school cybersecurity program. After a series of four focus group sessions, the rubric was refined and includes 6 categories with descriptors of achievements for each. The full rubric can be found in Appendix B. Shared below are the achievements required within each category to achieve a 5 Star recognition:

- **Curricular & Extra-Curricular Offerings**
    - The school has a dedicated **cybersecurity pathway** that meets all the learning objectives in the High School Cybersecurity Curriculum Guidelines. It is important to note that the High School Cybersecurity Curriculum Guidelines align to the CAE foundational KUs and to the essential knowledge statements in CSEC.
    - Instruction is culturally relevant and inclusive.

- The pathway includes opportunities for students to participate in internships and/or receive industry certifications and/or participate in a robust cybersecurity extracurricular program (~65 contact hours).
- Curriculum is rigorous, relevant, and engaging.
- Curriculum is aligned to workforce competencies.

- **Recruitment**
  - **The school has** active recruitment of students into the cybersecurity courses and pathway through at least 4 strategies (including offering honors credit, exploratory units/courses, clubs, competitions, guest lectures, enrichment, parent education, guidance counselor involvement, and/or outreach to middle schools).
  - Evidence of strategies to recruit a population representative of the school and/or to recruit students underrepresented in cybersecurity (i.e., female and students of color).
  - Institutions implement cybersecurity career exploration and discovery for students.

- **Student Success**
  - Students have completed a dedicated cybersecurity pathway and the school can provide completion data on the following:
    - All students have an opportunity in enroll in cybersecurity programs and courses
    - Number of completers in the pathway
    - Number and % taking a cybersecurity certification exam along with the Number and % receiving a cybersecurity certification
    - Number and % planning to continue their cybersecurity education (additional high school courses or in college)
    - Number and % planning to enter cyber workforce or enlist
    - Number and % involved in additional cybersecurity education (extra-curricular activities, internships, job shadowing etc.).
  - The school's specific strategies to maintain or improve the performance on the chosen metrics.

- **Sustainability**
  - Students and educators have access to state-of-the-art educational tools to teach and learn cybersecurity at school and home.
  - School has demonstrated commitment to continue offering and grow cybersecurity education. Evidence may include hiring a cybersecurity teacher, increasing the budget for the cybersecurity program, prioritizing dual-credit courses, etc.

- **Articulation**
  - The pathway is articulated to appropriate standards for preparing students for cybersecurity enrollment and/or employment. Of special interest is enrollment in the National Centers of Academic Excellence in Cybersecurity (NCAE-C) institutions.
  - Steps are underway to establish dual/concurrent enrollment and/or placement credit with higher ed.

- **Community Connections**

- Evidence of sustainable (more than 2 years) of community support from at least three organizations representing business and industry, higher education, nonprofit, military, etc. Evidence can include letters of support; letters of commitment to offer internship, job shadowing, etc. opportunities; endorsements; documented agreements / partnerships, etc.

### What would make such a recognition valuable to high schools?

The aspects of a recognition program that would be most valuable that were identified in the initial focus groups and the Criteria for Recognition focus groups were:

- **Funding:** schools expressed the desire/need to get direct funding with the designation. In addition to funds from the recognition program, where appropriate within a Career and Technical Education (CTE) program, Perkins funding may be available.
- **College & Career Pathways:** The designation should help K-12 schools develop articulation pathways to college and career. Informing students of cybersecurity jobs, as well as college opportunities to study cybersecurity as a career springboard. Such a program should help everyone send a more coherent and synchronized message to high school students about what they need to do early on to pursue a career in cybersecurity.
- **Dual/Concurrent Enrollment:** Providing assistance with students' college pathway (dual and transfer credit, scholarships, and college admission) that will also reduce the length of time for students to get an associate or bachelor's degree.
- **Prestige:** Having the program supported by a recognized cybersecurity authority (such as NSA) would help with student recruitment, parental support for their children to take the course(s), and industry support for the program.
- **Ongoing Developmental Support:** Having a community of schools/teachers to share best practices, an organizing body to coordinate and network among, as well as strategies for working with school IT staff and marketing programs would help the programs continue to develop and improve.

## Integration

How should a High School Cybersecurity Recognition program be positioned in the education sector?
The focus groups, case studies and landscape study found that cybersecurity programs are sparse, dissimilar, fairly new, resource-intensive, teacher-dependent, and precarious (full details can be found in the appendix reports). These factors will present challenges for integrating a recognition program into the education sector. Major findings include:

- **Cybersecurity Course Availability is Sparse**
  - 16% of U.S. regular public high schools have cybersecurity courses.
  - 22% of non-Title I schools have cybersecurity courses compared to 11% of the Title I schools.
  - 8% of very small schools (less than 600 enrolled students) have cybersecurity courses compared to 35% of very large schools (more than 2,000 students enrolled).
  - The 950 schools/CTE centers in the sample have 1799 cybersecurity courses. Nearly half, 46%, have a single cybersecurity course.

- There is significant variation by state. 61% of Virginia schools have cybersecurity courses and 8% of Arkansas schools do. Details on all 11 states are in the report.

- **Student Access to Cybersecurity is Low**
  - ~3.7% of the high school student population (~566,000) have access to a cybersecurity course in high school.
  - Access to cybersecurity courses is lower for students in Title I and small schools; ~2.4% of the student population in very small-small, Title I schools have access to a cybersecurity course.
  - ~4.7% of Asian students have access to cybersecurity courses in high school compared to ~3.8% URM and ~3.6% of White students.

- **Gateway-to-Cybersecurity Course Availability is Moderate with Areas of Concern**
  - 58% of U.S. regular public high schools have gateway-to-cybersecurity courses.
  - **68% of the non-Title I schools have gateway-to-cybersecurity courses compared to 52% of the Title I schools.**
  - **92**% of the large schools have gateway-to-cybersecurity courses compared to 44% the very small schools.
  - The 3548 schools/CTE centers in the sample have 11127 cybersecurity courses. 26% only have a single gateway course. 36% of the computing courses found in high schools are NOT gateways to cybersecurity.
  - There is significant variation by state. 91% of Maryland schools gateway courses and 46% of Arkansas schools do. Details on all 11 states are in the report.

- **Student Access to Gateway Courses is Moderate with Areas of Concern**
  - ~49% of the student population or ~7.5M students have access to a gateway in high school.
  - **Access is lower for students in Title I and small schools;** ~33% of the student population Title I, smaller schools have access to a gateway course in high school.
  - ~51.7% of Asian students have access to a cybersecurity course, compared to 49.0% URM students and ~48.4% of White students.

- **Availability of and Access to Cybersecurity Pathways is Meager**
  - ~7.9% of U.S. regular public high schools have enough gateway and cybersecurity courses to offer a sequence that would include 2 gateway and 2 cybersecurity courses.
  - ~1.0% of the student population in U.S. regular public high schools would have access to a cybersecurity pathway given the number of courses available.

**Dissimilarity:** Not only are there few schools that have cybersecurity courses and programs, the case studies, landscape study, and focus groups found that there is a considerable amount of variety in what is taught in these schools. This variation presents two concerns for a recognition program. The first is that high school education varies so much state by state in terms of what is taught and who controls what is taught. Some states are what some call "locally controlled," so trying to get something that is a state and/or national priority can be challenging. One participant noted "You cannot take a one size fits all approach. There needs to be various sizes and types of excellence. While I like the idea of models, a challenge is thinking that you can take something that has been demonstrated to work and be able to roll it out for local entities to adapt to their locality." The second concern around variation is the dynamic and quickly changing nature of the cybersecurity discipline. This begs the question as to whether a recognition can be innovative enough to retain any semblance of excellence when it resides in its host system (K-12), which is by nature slow and cumbersome.

Excellence can alternatively be measured by the strength of the high school's program of study pathway. Many of the issues addressed above are handled at the college level. The K12 programs are expected to support the program of study by enabling all students have the opportunity to participate in cybersecurity programs and classes, these programs include career awareness and exploration, foundational general education skills and exposure to foundational cybersecurity knowledge and skills.

**Resource Issues:** Due to the nature of the discipline, cybersecurity programs require technological and curricular resources that can be expensive for schools to invest in. They also require well-prepared and trained teachers capable of delivering the curriculum. And many are elective courses that require student enrollment numbers to continue to be offered. Thus, a recognition program should be positioned in a way that it is:

- **Data-Driven** - It should periodically collect data and report from K to 20 and then into the workforce. This would be essential to being a "program of excellence."
- **Capacity-Building** - Such a program needs to work from the bottom up as much as, or maybe more than, top down...at least right now. What is needed is more capacity building and enthusiasm to build critical mass.

Initial focus group participants discussed concerns around choice and variation as inhibiting the productive establishment of a recognition program. Regarding choice, the concern is more about the lack of choice. Participants noted that high school students and their parents have little choice to decide to enroll in a high school that is designated. This is quite different from the way that the NCAE program functions at the post-secondary level. So, while the intention is to have a designation for high schools for excellence in cybersecurity, such a designation will have little sway with parents and students.

Furthermore, K-12 schools are not really competing for students. Schools serve a given geographic area, not a certain group of students based on interests. This said, in a school that has cybersecurity, the cybersecurity teacher IS competing with other disciplines within the school.

For example, CTE programs compete with non-CTE programs in schools for students. Of the ~15 million high school students in the U.S., approximately 5.5% are enrolled in CTE programs. There are a total of 16

recognized career clusters in CTE. We found cybersecurity in the IT and STEM clusters, which enrolled 31% of the CTE students, or about 1.6% of all high school students in the U.S.

What would make such a recognition program achievable to high schools?

- **Funding -** schools should be able to get direct funding with this designation. Where appropriate within a Career and Technical Education (CTE) program, Perkins funding may be available to the high school It should be noted that Perkins allocations to states was ~1.38 billion in FY 2022 with roughly 64% of the funding going to secondary education and 36% going to post-secondary education. The implication of Perkins funding for a high school cybersecurity designation program needs careful and considerable deliberation.
- **Capacity-Building** - access to curriculum, instructional resources, valid assessments, teacher preparation and professional development, extra-curricular offerings, tools, and technologies, etc.
- **Developmental** - The program's focus should be developmental (as opposed to static or recognition only) and emphasize continuous improvement (not a one and done approach).
- **Flexible** - The criteria would need to be flexible enough (which runs counter to the recommendation for standardization) to recognize these differences and not penalize schools in states that cannot achieve a level due to systemic factors outside the school's control.

## Implementation

### What factors need to be considered to implement a High School Cybersecurity Recognition program in a manner that substantively addresses the workforce shortage?

Some of the initial focus group participants, especially those in the business and industry, expressed a concern about designing a pipeline to address the cybersecurity talent gap when we really do not understand the talent gap. One participant poignantly noted "maybe the schools are not producing what employers are looking for, and/or maybe employers are being unrealistic in what they are looking for coming out of those pipelines." In the case of the former, there is no sense building a feeder system into college until we can assure that graduates are getting the knowledge and skills needed in college. In the case of the latter, if employers are being unrealistic in their expectations for graduates coming out of those pipelines, the friction in the pipeline is not necessarily occurring in the educational system. Therefore, an educational solution would not ameliorate the problem. This viewpoint was echoed by another participant who said:

> *"I do not think companies know what they want/need when they say they need cybersecurity talent. I think there is more than one pipeline. There is a pipeline for operators, i.e., people who maintain the security of existing systems. There is a pipeline for innovators who are designing the systems, and therefore the security, of the future. And there is a pipeline for people who can help us migrate from what we have to where we're going in the future. But we do not know much about these pipelines. Of the workforce talent gap, do we need a third in each area? Or is it something different? If you could answer this, then you might be able to say something meaningful about what type of program of excellence is needed."*

## Benchmarking Other Recognition Programs

In the comparative study of high school designation and award programs the research team discovered that there are two major types of programs. Full details are available in Appendix D. The two program types will be described as recognition programs and designation programs. The research indicates the type of program implemented by the groups studied were based on several factors. These factors can include the purpose or goal of the program, the costs involved, and resources available to operate the program and the potential target size of the program. One of the major factors is the ability to manage and operate the program over a longer term. In some cases, recognition programs transitioned into designation programs. Another major factor that must be considered when comparing existing programs would be the popularity and response level to these programs. The research indicated that programs with award criteria more generally align to overall academic standards are in general more popular. Programs that are subject or career specific are not as widely pursued.

## Recognition Versus Designation

Recognition programs are designed to bring attention to outstanding institutions, administration, staff, faculty and/or students. Many of these programs limit the number of awardees each cycle, others were open to any institution that qualifies. Some programs are centrally or nationally managed. Other programs were locally managed, this typically meant the sponsors provide a broad framework of requirements and grant states or regions the authority or responsibility to set the selection criteria. For example, the National Blue-Ribbon award sponsored by the US Department of Education limits the number of recipients by state. Each state is required to organize a committee to manage the nomination process. In this type of model, more populated states get more annual recipients than less populated states. Some programs are driven by state level nominations, while others require the institution to complete an application process. These programs typically culminate in a national event to recognize the recipients.

Designation programs require institutions to meet criteria to earn a designation. The designation is typically good for a specific period at which time the institution must re-designate like the CAE-CD program. These programs typically cost more to manage, require more resources, and are designed to promote continuous improvement. Designation programs are much more burdensome on the applicate institutions and on the designating organization. Many of these programs define multi-levels of designation, for example 5-star, 4-star and 3-star. They tend to encourage under-performing schools to improve their programs and work toward excellence. Designation program can leverage the designated community to address specific needs or academic issues. Designation programs typically have some benefits for maintaining the designation.

The benchmarking study also identified two methods of operating these programs: centralized and decentralized. The decentralized programs are the most common approach to program management. This approach recognizes the difference in state operations of the schools and differences in the local workforce requirements. This approach encourages local promotion and ownership of the program.

Centralized management is controlled nationally. Centralized programs are more standardized and implement a more formal review of the benchmarks. These programs tend to be just recognition programs.

The National Blue-Ribbon Schools Program is the most prestigious recognition program awarded by the United States Department of Education. The program recognizes exemplary public and non-public schools on a yearly basis. Exemplary Schools are selected based on the state's highest performing schools as measured by state assessments or nationally normed tests. The award also recognizes exemplary achievement by schools closing achievement gaps between a school's subgroups and all students over the past five years.

The benchmarking study of both recognition or designation programs discovered common indicators or benchmarks of exemplary performance. The indicators reflect federal, regional, and local priorities in addressing workforce demands. The benchmarks serve as overall criteria, however most of the recognition programs leave the review and interpretation up to local review teams or State Departments of Education. The following are indicators of performance that are common across many of the recognition or designation program:

- Program provides all students with equal access to enroll in the career education program.
- Program must include career exploration at both middle and secondary levels.
- Programs include a sequence of technical courses that progress from introductory exposure of all aspects of an industry to more advanced technical knowledge and skills.
- Program provides rigorous and relevant academic content and relevant technical knowledge and skills needed to prepare for further education and careers.
- Program includes competency-based, work-based, or other applied learning that supports the development of academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, employability skills, technical skills, and occupation-specific skills, and knowledge of all aspects of an industry, including entrepreneurship, of an individual.
- Program provides technical skill proficiency or a recognized postsecondary credential.
- Program coordinates between secondary and postsecondary education programs through programs of study.
- Programs must be large enough to support a community learning environment with peers.

## Case Studies of Existing Leading HS Cybersecurity Programs

Two schools from the case studies noted having job shadowing or internship requirements. One of the two schools reported that the school's creation was due to industry lobbying the state government for its creation. Another school had students who mentioned benefitting from internship opportunities related to the associated CyberPatriot club's success.

## Utilization

### How many schools would be expected to utilize the recognition?

Landscape Study of Existing HS Cybersecurity

- 16% of schools have cybersecurity courses – about half only have a single course. We estimate 4.7% of the U.S. regular public high schools would be eligible for full recognition, with another 3.2%In real numbers, the estimate is 657 - 1099 schools. However, unless there are perceived benefits to getting the recognition (discussed early) then it is likely the numbers will be considerably lower.

### What is the projected growth curve for the High School Recognition Program?

Landscape Study of Existing HS Cybersecurity

- We expect cybersecurity to continue to grow in U.S. high schools. We expect the growth to be manifest in the addition of cybersecurity lessons, units, and full courses. At this time, we do not expect to see significant growth in cybersecurity pathways.
- Given Perkins funds, it seems that cybersecurity will most likely grow in CTE programs. In some states computer science is in CTE, but in other states it is not. This is pertinent because computer science is now in 53% of U.S. high schools and is an important part of growing cybersecurity pathways (State of CS Education Report 2022). In this report, a CS course is one that has a minimum of 20 hours of programming/coding. We project that the cybersecurity growth curve will lack computer science in states where computer science is not in CTE - in other words, in these states' cybersecurity will be heavily, and almost exclusively, IT-based.

### Case Studies of Existing Leading HS Cybersecurity Programs

The case studies identified two major factors in the growth of high school cybersecurity: a) state-level mandates (i.e., Virginia and program A) and b) local, district or school-level motivations (i.e., Texas and California). The role of extracurricular programs (competitions and clubs) was another contributor to program creation and sustainment.

## Sustainability

### What factors will affect sustainability and how?

According to the comparative case study of four programs, the following are three factors affecting sustainability:

- **Student Recruitment:** Although three of the four programs were not currently struggling with student enrollment numbers, student recruitment was the component of sustainability identified by the interviewees at all 4 sites. Two of the programs had a competitive pool of candidates with waitlists for their programs with one having a lottery and another an application and interview process. One of the programs prioritized recruitment but indicated their numbers were high enough to the point of potentially needing a wait list. The fourth program was concerned about student enrollment numbers.

- **Teacher Advocate:** The research team noted the importance of a teacher advocate for the sustainability of the program. For example, at one of the schools, every interviewee mentioned having an inspiring/passionate teacher as the most important factor to the program's success. One of the programs had a nationally recognized program and another had a teacher who led the design of the new facility and curriculum while teaching the courses. Another teacher developed summer camps and a parent booster club to help support and fund the program. All of the programs appear dependent on the current teachers' passions and activities to support the sustainment of the program to varying degrees.

- **External Support:** Industry partners, parents, and mentors were all identified as key to sustaining the programs. For example, the counselors at the school noted the students attending the school had unique internship opportunities that make programs like cybersecurity attractive to students and beneficial to the community. And at another school, adult mentors were used to maintain equipment and coach extracurricular teams tied to the program.

The comparative case study of the four high school cybersecurity programs identified several roadblocks to the sustainment of their programs. These roadblocks included the expense of such programs, the lack of teacher resources and curriculum, the lack of teacher training, teacher retention, varied student skills, keeping up with program growth, a lack of community understanding of cybersecurity careers, technology needs, the need to update curriculum, and the fear of students' actions. A sustainable recognition program will depend upon sustainable high school programs to recognize.

The landscape study found that programs that were de-centralized and included community involvement were the programs that maintained the greatest level of sustainability. In addition, recognition programs were less expensive and were easier to sustain. The study also revealed that programs that provided continuous improvement activities also benefited with great sustainability.

## Feasibility

**Feasibility** – The landscape research team concluded that a recognition program would be feasible, but a designation program is not currently feasible for the following reasons:

- cybersecurity courses are too few in high schools and pathways even fewer
- a cybersecurity pathway would need to include prerequisite computer science and IT courses, which also are not available in nearly half of America's high schools
- while few cybersecurity high school courses and pathways exist, those that do vary greatly in scope in high schools
- even in the schools where cybersecurity is "more established",
    - it is dependent on a single teacher (and would likely fail if s/he left),
    - the curriculum is changing quickly and formatively, where what was taught this year is very different from what was taught last year
- cybersecurity pathways, courses, and prerequisite gateway courses are more prevalent in non-Title I schools, in larger schools, with notable variation by state; a designation program would advantage larger schools, non-Title I schools, and certain states
- requirements for what should be taught need to be established, these requirements need to be flexible to allow for state variation, but also somewhat homogeneous to promote articulation with CAE schools and to promote quality/rigor in student learning
- while requirements need to be carefully considered, so do incentives and rewards; a designation program would recognize schools that meet a certain quality standard, but meeting that quality standard will only become important to the schools if there are accompanying resources and prestige
- the costs and benefits are still undetermined and need to be studied next; we estimate is has cost roughly $100 million to get to 53% computer science courses in America's high schools so the investment in building capacity needs to be carefully considered as well as anticipated costs to operate a recurring high school designation program that includes an application process, reviews, feedback, and incentives/rewards

**Advisability** – A recognition program would be advisable as a precursor to a full designation program. Although there is interest in a high school designation program it would not be admissible at this time without first taking steps to grow the community and build high school cybersecurity programs' maturity.

This approach would potentially include more high schools across the country who can demonstrate a certain level of cybersecurity education to earn a star rating. However, this approach might not serve to provide a clear picture of what is exemplary for high school cybersecurity education to have a targeted impact of closing the cybersecurity workforce gap.

# APPENDIX A

# Initial Focus Groups Study

**Dr. Melissa Dark**
DARK Enterprises, INC.

**Dr. Jenny Daugherty**
DARK Enterprises, INC.

APPENDIX A

# Initial Focus Groups Study

## Executive Summary

Stakeholder analysis was used to identify all key stakeholders who have a vested interest in the issues with which the project is concerned. The stakeholders interviewed for this project were from the following stakeholder groups: higher education; K-12; business and industry.; and the government. Two focus groups were conducted for each group for a total of 8 focus groups and 30 participants.

The content analysis of the focus group data is grouped according to targeted benefits, that:

They reported that benefits should accrue to the following groups:

- K-12 schools to include:
  - High school principal
  - CTE director
  - Guidance counselors
  - CAE Schools
  - High school teachers
  - School corporation superintendents
- K-12 students.
- Higher education.
- At large.

Not all stakeholder groups reported that there should be benefits for all four groups, nor did the stakeholder groups report the same benefits. The themes with regard to benefits that emerged are:

- Build K-12 Teaching Capacity
- Other Benefits to K-12 Schools
- Benefits to Students
- Benefits to Higher Education
- At Large Benefits

Stakeholders were also probed for constraints/challenges. The themes that emerged were:

- Trying to Solve a Problem We Don't Understand
- Asking Too Much and Resourcing too Little
- Choice (Or the Lack Thereof) and Variation

Final considerations that came forward during the focus groups include the following:

- Such a program should be data driven. It should collect data and report from K to 20 and then into the workforce. This would be essential to being a "program of excellence."
- Such a program needs to work from the bottom up as much as, or maybe more than, top down...at least right now. This participant felt strongly that we might not be ready to institutionalize HS Cybersecurity; instead, what is needed is more bottom-up capacity building and enthusiasm to build critical mass.

# Full Report

The methodology used for the initial data collection was focus group interviews. Focus group interviews are, first and foremost, a data collection opportunity. Focus group interviews are neither problem-solving nor decision-making events. The object of a focus group is to get high-quality data in a social context where people can consider their own views in the context of the views of others. It is not necessary for participants to agree with each other or reach consensus. A focus group is a common qualitative approach used to gain an in-depth understanding of the topic of investigation. A focus group interview involves a small number (usually 4-10) of demographically similar people or participants who have other common traits/experiences. Their reactions to specific researcher/evaluator-posed questions are studied. Because focus groups are a qualitative data collection method, the data are descriptive and cannot be measured numerically.

In this study, the research team is particularly interested in the views of various stakeholders. Stakeholder analysis was used to identify all key stakeholders who have a vested interest in the issues with which the project is concerned. The aim of the stakeholder analysis process is to develop a strategic view of:

- the human and institutional landscape, as well as the relationships among the different stakeholders,
- the issues the stakeholders care about most and
- assessing a system and potential changes to it as they relate to relevant and interested parties.

This information is used to assess how the interests of those stakeholders should be addressed in a project plan, policy, program, or other action. The stakeholders interviewed for this project were from the following stakeholder groups:

- Higher education.
- K-12.
- Business and industry.
- Government.

The team developed a logic model to provide an overview of the factors involved in recognizing cybersecurity programs at the high school level. Logic models help to illustrate the relationship between our activities (input) and our desired outcomes. In planning and evaluating this project, our logic models offer a clear and continuous method for forming activities in a logical and effective sequence and serve as a tool for tracking progression towards the goals of the study. This logic model included the inputs, activities, outcomes, and impacts of such a recognition, and the model was used to drive the line of questioning (see Figure 1):

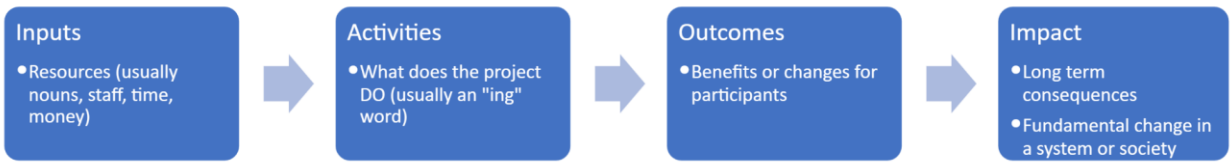



***Figure 1.*** Logic model

The groups were asked the following questions:

1. Below are three cybersecurity education challenges that are frequently discussed. Which resonate with you as a high priority challenge and why?
    a. build the cybersecurity education-workforce pipeline,
    b. educate a more cybersmart populace, and
    c. develop capacity for teaching cybersecurity in high school

2. What do you think the benefits would be of a program that recognizes excellence at the high school level?
3. What might be the obstacles or challenges to such a program?
4. What would be your role, if any, in this type of program?
5. Could you envision supporting, managing, or participating in a high school program of excellence?
6. Who else should we be talking to?

Each member of the focus group was invited to respond to the questions above; however, to encourage participation, each member of the focus group was invited to lead the discussion around a selected question. This study used a structured interview guide meaning that interviewees were asked the same questions in the same order.

Two focus groups were conducted for each group for a total of 8 focus groups. Table 1 below outlines the selection criteria, dates, and number of participants for these 8 focus groups.

| | **Selection Criteria** | **Date** | **# of Participants** |
|---|---|---|---|
| **Higher Ed Groups** | Selection criteria:<br>● At least one school in each of the 5 regions<br>● Representation across all designations<br>● Four year and community colleges | Feb 11, 2021 | 5 |
| | | Feb 18, 2021 | 6 |
| **K-12** | Selection criteria:<br>● Geographic diversity<br>● Role diversity, i.e., teachers, administrators, state DOE representatives | March 11, 2021 | 5 |
| | | March 18, 2021 | 6 |
| **Business/Industry** | Selection criteria:<br>● Public and private sector employers<br>● Professional associations | May 19, 2021 | 4 |
| | | May 20, 2021 | 4 |
| **Government** | Selection criteria:<br>● Public sector administration with responsibility for cybersecurity education in the United States | June 24, 2021 | 4 |
| | | June 25, 2021 | 4 |

***Table 1.*** Selection criteria, dates, and number of participants for focus groups.

The focus groups were recorded, and the University of Alabama Huntsville was responsible for transcribing them. All have been transcribed. DARK Enterprises Inc. was responsible for analyzing the focus group data and identifying major themes.

Content analysis was used to identify key themes. Content analysis is commonly used in social science research and entails the study of documents and communication artifacts, which might be texts of various formats, pictures, audio or video. Content analysis is a research technique used to make replicable and valid inferences by interpreting and coding textual material with the goal of reducing elaborate text into fewer content categories. This analysis has been completed.

## Findings from Step 1

Stakeholders were asked to share their perspectives on the potential benefits of a HS CAE program. This question was specifically asked to measure acceptability and interest of a HS CAE program from each of the focus groups perspectives. Content analysis identified that benefits should accrue to the following groups:

- K-12 schools to include:
    - High school principal
    - CTE director
    - Guidance counselors
    - CAE Schools
    - High school teachers
    - School corporation superintendents
- K-12 students.
- Higher education.
- At large.

Not all stakeholder groups reported that there should be benefits for all four groups, nor did the stakeholder groups report the same benefits. The themes with regard to benefits that emerged are:

- Build K-12 Teaching Capacity
- Other Benefits to K-12 Schools
- Benefits to Students
- Benefits to Higher Education
- At Large Benefits

Stakeholders were also probed for constraints/challenges. The themes that emerged are:

- Trying to Solve a Problem We Don’t Understand
- Asking Too Much and Resourcing too Little
- Choice (Or the Lack Thereof) and Variation

Benefits and constraints are discussed below in a rough order of priority with those being cited most often at the top of the list.

# Benefits

## Build K-12 Teaching Capacity

The most frequently mentioned benefit was that such a program should build K-12 teaching capacity. While this benefit was cited by several participants across all focus groups, building teaching capacity means different things to different stakeholders. While a majority of participants felt that the top priority for such a program was to build K-12 teaching capacity, there was no consensus on **what type** of teaching capacity should be built. Some participants expressly noted that the teaching capacity that should be built should focus broadly on K-12 cybersafety/data hygiene/data care. The rationale for this focus is captured in the following statements:

- "The highest benefit for such an effort is building the capacity for teaching and I would not limit it to high school or to technology."
- "The goal should be to create a cybersmart populace, and then you will have a nearly limitless supply of possible cybersecurity talent. And then industry and academia will have to figure out how to evolve to absorb all these folks/all this talent into their systems."
- "Teaching cybersafety (broader and shallower) to all instead of deep cybersecurity to fewer, is accessibility. Because most people do not have choice where they go to high school, this approach affords us the best chance of reaching traditionally underserved populations."

While other responses suggest that teacher training and capacity building should be more disciplinary.

- "The biggest benefit needs to be for teachers and teacher training. Just like when CS for All started."
- "For us, it's more about foundational computer science. That's kind of the terminology we're using in terms of the five core concepts from the standard because we feel that the foundation is what leads students into cybersecurity as opposed to being in cybersecurity itself."

Many participants described aspects/components of teaching capacity that ought to be "built". One common theme was that the program should focus on building capacity by outlining the learning progression(s) needed for high school students to prepare for cybersecurity employment, enlistment, and/or enrollment. In terms of building learning progressions, participants noted the following important aspects:

- High schools would need to have a pathway, i.e., one course would not be enough.
- The recognition should include accommodations to recognize different pathways in different schools.
- Pathways need to be tied to specific learning outcomes that are appropriate for high school students.
- the learning outcomes need to create a real mapping with the KUs.
- support dual credit, if based on KUs – connect or transfer from high school to college.

Yet other participants reported that in order to help high schools build pathways, we must first help them build the component parts of pathways such as:

1. curriculum
2. tests
3. embedded assessments
4. clubs
5. competitions
6. community
7. teacher preparation and credentialing

Finally, participants reported that in order for uptake to occur, the value proposition needs to be clear and compelling. Aspects of the value proposition are discussed in subsequent sections.

In summary, building teaching capacity was noted by most as the lynchpin to "building the cybersecurity workforce pipeline". Some participants emphasized building teaching capacity for cybersafety, some prioritized building teaching capacity for cybersecurity, and some felt that it is not an either-or proposition, that such an effort should build teaching capacity in both cyber safety and cybersecurity in order to be acceptable and effective.

Regarding what it means to "build teaching capacity," the analysis of the focus groups found that a "systems" perspective is needed to include:

1. Curriculum and courseware that creates pathways
2. Teacher professional development and credentialing
3. Community to support the above

An important component of the high school cybersecurity system is the development of cybersecurity pathways. In establishing cybersecurity pathways, the following were identified as needed:

- Learning progressions to formalize the pathways
- Agreed upon learning outcomes
- Flexibility to prepare students for cybersecurity employment, enlistment, and/or enrollment
- Support for dual credit (to be based on the KU and/or ABET accreditation used in higher education)
- Curriculum, courseware and assessments

## Other Benefits to K-12 Schools

Several themes emerged regarding other benefits to K-12 schools. Participants in the higher education, K-12 and government focus groups all reported that a high school CAE designation should help schools set themselves apart. Concrete manifestations of this included:

- Schools should be able to get direct funding with this designation.
- The designation should help K-12 schools develop articulation pathways. And when possible, these articulation pathways should be used to recruit incoming families to settle in certain areas/school districts.

## Benefits to Students

Several ideas were put forth about the benefits that should accrue to high school students. These include:

- Informing students of cybersecurity jobs post high school (career awareness), as well as college opportunities to study cybersecurity as a career springboard. Such a program should help everyone send a more coherent and synchronized message to high school students about what they need to do early on to pursue a career in cybersecurity.
- Providing assistance with their college pathway (dual and transfer credit, scholarships, and college admission) that will also reduce the length for students to get a bachelor's degree.
- A HS CAE program should benefit students who go right into the workforce too. It needs to be diverse enough to create opportunities for everybody and should produce more certifications to prepare job ready graduates.

A few of the participants felt strongly that such a program of excellence should focus more on educating high school students to be safer in cyberspace with a secondary goal of feeding high school students into cybersecurity college programs and careers. This theme was mentioned above in the section on Building K-12 Teaching Capacity. These participants felt strongly that in order to reach a broader and more diverse set of students, focusing on cybersafety is imperative. In other words, a focus on cybersecurity is too narrow and deep and by default would exclude opportunities for traditionally underserved student populations.

## Benefits to Higher Education

The following ideas were put forth, mostly by the higher education group, about the benefits that should accrue to higher education:

- A HS CAE designation should feed high school students into collegiate cybersecurity programs.
- A HS CAE designation should feed high school students into collegiate computing programs, and not just into cybersecurity programs.
- A HS CAE designation should make it clear to colleges and universities where to go to recruit cybersecurity graduates to matriculate into their collegiate programs.
- A benefit is recruitment and retention. HS students take some of the courses in high school so they will have higher confidence to continue in college, increasing the retention rate.

## At Large Benefits

Finally, there were some benefits discussed by stakeholders (largely in the Business and Industry and Government groups) that were not per se benefits to a particular stakeholder group. These have been termed "at large" benefits and include:

- The biggest benefit of such a program is "visibility." Using language to create a buzz.
- A more cyber literate populace benefits society at large.
- A better prepared cybersecurity workforce benefits everyone.

- A benefit will be having a community of practice with standards where we're all speaking the same language.
- A HS CAE program should create a model for other schools and regions to emulate both excellence and how to get there.

# Constraints

In addition to interviewing participants to determine what would make a HS CAE Program acceptable, step 1 included questions about obstacles to creating such a program. After analyzing the transcripts, several themes emerged regarding the obstacles. These constraints described more fully below are:

- Trying to solve a problem we don't understand
- Asking too much and resourcing too little
- Choice (and lack thereof) and variation

## Trying to Solve a Problem We Don't Understand

Some of the participants in the business and industry focus groups expressed a concern about designing a pipeline to address the cybersecurity talent gap when we really do not understand the talent gap. One participant poignantly noted "maybe the schools are not producing what employers are looking for, and/or maybe employers are being unrealistic in what they are looking for coming out of those pipelines." In the case of the former, there is no sense building a feeder system into college until we can assure that graduates are getting the knowledge and skills needed in college. In the case of the latter, if employers are being unrealistic in their expectations for graduates coming out of those pipelines, the friction in the pipeline is not necessarily occurring in the educational system. Therefore, an educational solution would not ameliorate the problem. This viewpoint was echoed by another participant who said:

> *"I do not think companies know what they want/need when they say they need cybersecurity talent. I think there is more than one pipeline. There is a pipeline for operators, i.e., people who maintain the security of existing systems. There is a pipeline for innovators who are designing the systems, and therefore the security, of the future. And there is a pipeline for people who can help us migrate from what we have to where we're going in the future. But we do not know much about these pipelines. Of the workforce talent gap, do we need a third in each area? Or is it something different? If you could answer this, then you might be able to say something meaningful about what type of program of excellence is needed."*

## Asking Too Much and Resourcing Too Little

Participants in the K-12, government, and business/industry groups all expressed concern about asking too much from a HS CAE program without adequately resourcing it. In addition to the need to develop more cybersecurity teachers (as reported above as one of the biggest potential benefits), participants cited the investment needs to be made to 1) create programs to credential teachers in teaching cybersecurity and 2) support the cost to teachers to become credentialed. This concern seems particularly salient in a time when we still have several states without credentialing requirements for teaching computing/computer science in high school.

Participants also mentioned that resources are needed to build infrastructure to teach cybersecurity where infrastructure could include state standards and core curriculum. For schools that have no cybersecurity courses, they want a course, whereas for schools with one course, they may want a second course. Ultimately schools will need the entire pathway. Finally, schools need the technical infrastructure (e.g., cyber ranges) to teach hands-on cybersecurity.

Beyond teachers, participants reported that investments need to be made to create dedicated cybersecurity positions in state and local education agencies as these positions are key to building teaching capacity, creating credentialing programs, establishing state standards, and provisioning technical infrastructure. For some schools, the challenge is buy in and/or the crowded curriculum. Figuring out where to teach cyber in a school will depend on a lot of local conditions and constraints.

Finally, participants in the K-12 focus groups mentioned needed resources such as internships, guest speakers, and recruiting materials to draw students into cybersecurity.

## Choice (or the Lack of) and Variation

Finally, participants discussed concerns around choice and variation as inhibiting the productive establishment of a HS CAE program. Regarding choice, the concern is more about the lack of choice. Participants noted that high school students and their parents have little choice to decide to enroll in a high school that is a CAE. This is quite different from the way that the CAE program functions at the post-secondary level. So, while the intention is to have a designation for high schools for excellence in cybersecurity, such a designation will have little sway with parents and students. Furthermore, K-12 schools are not really competing for students. Schools serve a given geographic area, not a certain group of students based on interests.

Two concerns came forward regarding variation. The first is that HS education varies so much state by state in terms of what is taught and who controls what is taught. Some states are what some call “locally controlled,” so trying to get something that is a state and/or national priority can be challenging. One participant noted “You cannot take a one size fits all approach. There needs to be various sizes and types of excellence. While I like the idea of models, a challenge is thinking that you can take something that has been demonstrated to work and be able to roll it out for local entities to adapt to their locality.”

The second concern around variation is the dynamic and quickly changing nature of the cybersecurity discipline. This begs the questions as to whether a HS CAE can be innovative enough to retain any semblance of excellence when it resides in its host system (K-12), which is by nature slow and cumbersome.

# Additional Considerations from Step 1

As mentioned in the introduction, the term HS CAE may not be apt. When interviewing the stakeholders, suggestions were offered on potential titles and models for investigation as this study moves into steps 2-5 as follows.

Perhaps the idea of a program of excellence is more fitting for the high school level than a center of excellence. Some participants felt that a program of excellence should be reserved for an entire pathway, while others advocated for a broader, more inclusive approach. For example, schools could apply to be a Level 1 Program of Excellence, a Level 2 Program of Excellence, or a Level N Program of Excellence. The idea is that criteria would be established for each level and schools can progress to the next level if and when they are ready. Some participants also felt that the program should allow for and even encourage a tie-in to local needs. In some locales, a HS Cyber Program of Excellence might be best focused on protecting hardware, whereas in other locales software might be a better emphasis.

Participants offered a couple of models. The first is the “Academies” model where a school is certified for teaching certain content, e.g., Cisco Academy. The second is more holistic in recognizing several facets such as curriculum, credentials of teaching staff, number of enrollees, number of certifications earned, number of graduates pursuing a college degree in cybersecurity, etc. Participants suggested IB and/or Blue Ribbon Schools might be useful models. One participant noted that not every school should have to report on every criterion.

Continuing in this vein, a few participants emphasized that the most important aspect of a HS Program of Excellence is that is creates opportunities for students; schools should be able to nominate themselves based on how they create opportunities using the above (curriculum, credentials of teaching staff, etc.) as prospective, but not necessarily required, criteria.

Final considerations that came forward during the focus groups include the following:

- Such a program should be data driven. It should collect data and report from K to 20 and then into the workforce. This would be essential to being a “program of excellence.”
- Such a program needs to work from the bottom up as much as, or maybe more than, top down...at least right now. This participant felt strongly that we might not be ready to institutionalize HS Cybersecurity; instead, what is needed is more bottom-up capacity building and enthusiasm to build critical mass.

# APPENDIX B

# Criteria for Recognition Study

**Jenny Daugherty**
DARK Enterprises, INC.

**Dr. Melissa Dark**
DARK Enterprises, INC.

**Tania Williams**
Assistant Director, Center for Cybersecurity Research and Education (CCRE)
The University of Alabama in Huntsville

APPENDIX B

# Criteria for Recognition Study

## Executive Summary

This portion of the study proceeded with the assumption that a program of excellence would be established and have an impact or change the educational ecosystem. A series of focus groups were conducted in four states (Maryland, Florida, Texas, and California) with 41 participants (high school teachers, administrators, educational agency and nonprofit representatives) from December 2021 - May 2022. A summary of each focus group findings is presented in Appendix A. The research team created a proposed set of multi-level criteria in the form of a rubric (see Appendix B). The rubric has 5 levels that were denoted as stars where one star reflects a program at the entry level of building a cybersecurity program and five stars comprises a state-of-the-art high school cybersecurity program.

Four broad themes were identified from the focus group findings and are summarized below.

1. The focus group participants were interested and positive about the creation of a high school recognition program especially from a recognized cybersecurity authority (i.e., NSA).
2. The program's focus should be developmental (as opposed to static or recognition only) and emphasize continuous improvement (not a one and done approach). Participants recognized value in having clear benchmarks of success to strive toward; a community of schools/teachers to share best practices; and an organizing body to coordinate and network among.
3. The tension between how K-12 education operates in the United States (state and locally led) and establishing a national program with standard criteria means the program should be as flexible as possible. The criteria would need to be flexible enough to recognize these differences and not penalize schools in states that cannot achieve a level due to systemic factors outside the school's control.
4. The need to be aware of and account for environmental factors (enablers and barriers described fully in the report) to growing cybersecurity programs and pathways in establishing criteria for a recognition program.

Several questions concerning the implementation of a recognition program should be considered:

- Who is paying for the school's effort to participate in gathering the data, reporting, and managing the process?
- How often will the recognized schools be re-evaluated?
- How many criteria are required for the school to be recognized?
- How could the integration of cybersecurity topics across the curriculum be recognized?
- How does a national program work across states when there are no national standards?

Finally, several recommendations were offered including:

- Create a clear, specific mission statement to guide the program.
- Establish value statements that reflect the program's mission and the evaluation criteria.
- In terms of frequency for re-evaluation, a suggestion is to have a 3-year cycle.
- Be mindful of requiring criteria that can privilege some states/programs that have resources over those that do not.
- Incorporate other roles in the program beyond recognition. Ideas included:
    - Developing a community of practice between the recognized schools/programs to share resources, technology recommendations, and support.
    - Create a clear alignment of the recognition program to CAE institutions for college acceptance, scholarships, and dual-credit.
    - Support high school programs by offering student scholarships, teacher professional development, access to cyber ranges, and other mechanisms to offset some of the costs associated with running a cybersecurity program.
    - Becoming an intermediary between the cybersecurity program and the school's IT by providing a list of approved software and devices needed to run a cybersecurity program.
    - Organizing an annual meeting to develop community, share best practices, and as an opportunity for professional development.

The potential outcomes and impact of the recognition program depends on the criteria and process, the incentives provided, as well as whether and to what degree key stakeholders value the program that results. If there are fewer incentives to participate, involvement might be low and thus the impact the program can make would be less. And if programs are incentivized and the criteria are few, more programs might participate but the impact on advancing high school cybersecurity education might also be less. If a recognition program is created, it will have both intended and unintended consequences on high school cybersecurity education.

# Full Report

This study used the Theory of Change Methodology to understand how potential recognition criteria and a recognition program would contribute to the growth and excellence of high school cybersecurity education. The research question this effort sought to answer is:

### What conditions and features should exist in a high school cybersecurity recognition program that would recognize excellence?

Based on the initial set of focus groups, some stakeholders believe that secondary schools in the United States are not ready for a high school recognition program. However, other stakeholders believe that designation in quality cybersecurity education in secondary schools is timely. This study proceeded with the assumption that a program of excellence would be established and have an impact or change the educational ecosystem. The team explored the structure, criteria, incentives, and barriers to such a program.
Guiding questions were:

1. What should the criteria be?
    a. Should the program recognize technical skills, academic skills and/or employability skills?
    b. Should the program recognize general education, college prep, and/or career and technical education?
    c. Should the program recognize some or all of the following:
        i. quality, amount and/or type of instruction,
        ii. recruitment,
        iii. counseling business support,
        iv. teacher capacity and quality,
        v. articulation,
        vi. extra-curricular activities,
        vii. outreach,
        viii. student success,
        ix. student opportunity,
        x. community of practice?

    d. Should the program recognize inclusion?
    e. Should current workforce needs, competencies, emerging technologies, articulation requirements and existing workforce frameworks including the NIST/NICE framework guide the program criteria?

2. What would be designated? A course, a program, a school, a district?
3. How will performance be measured?
4. How flexible should the criteria be?

   a. Should the recognition improve participation, consistency and/or rigor? Can it do all three? If yes, how will designation improve participation, consistency and/or rigor?

5. Who would enforce the criteria?
6. Where would the funding come from and how would the funding be used?
7. Based on the above, what would be the anticipated intended and unintended consequences? Are the intended consequences likely to contribute toward building the cybersecurity workforce highway? Can we forecast how to mitigate undesired unintended consequences?

# Method

In order to inform these questions a series of focus groups were conducted in four states where cybersecurity education has a foothold in the high schools: Maryland, Florida, Texas and California. 41 participants (high school teachers, administrators, educational agency and nonprofit representatives) participated in these four focus groups from December 2021 - May 2022.

A proposed set of criteria were created as a model to focus the conversation and elicit reactions during the focus group. Based on the team's collective experiences and the Initial Focus Groups (occurring during the first phase of the project), the research team created a proposed set of multi-level criteria in the form of a rubric. The rubric has 5 levels that were denoted as stars where one star reflects a program at the entry level of building a cybersecurity program and five stars comprises a state-of-the-art high school cybersecurity program.


The rubric originally included 7 prospective achievement categories, which were revised after the initial two focus groups (Maryland and Texas) to the following 6 categories:

1. Curricular & Extra-Curricular Offerings
2. Recruitment
3. Student Success
4. Sustainability
5. Articulation
6. Community Connections

The team assumed that in order to substantially build the cybersecurity workforce, the recognition would need to recognize noteworthy achievements, and a significant number of schools would need to attain and aspire to attain the HS Cybersecurity Recognition. And in order to have a significant number of schools attain or aspire to attain the HS Cybersecurity Recognition, the recognition would need to be achievable and valuable to them.

After giving the participants time to reflect and respond to the set of criteria, the focus group participants were guided through understanding the rubric as a set of conditions that progress from an entry level

(standalone cybersecurity learning activities) to an optimal level (full cybersecurity classes connected to certifications and articulation to higher education). The facilitators led the participants through the levels of each criteria asking probing questions. Three note-takers were present in the sessions to capture participant feedback.

Stakeholders representing key roles in the high school education ecosystem (i.e., teachers, administrators, state-level and government representatives, college faculty, and educational nonprofits) participated in four focus group sessions (six participants in the Maryland focus group in December 2021; 12 participants in the Florida group in January 2022; 10 participants in the Texas focus group in March 2022; and 13 participants in the California focus group in May 2022), provided feedback on a set of proposed criteria and dimensions, offered recommendations to revise or amend the proposed criteria, and provided suggestions to consider in creating a recognition program. The Maryland and Texas focus groups occurred in-person. The Florida and California focus groups were hybrid with some of the participants in person and some online.

# Findings

After reviewing all the project team's notes and the summary feedback, themes from the focus groups collectively were identified and are presented next. A summary of each focus group findings is presented in the Appendix.

- The focus group participants were interested and positive about the creation of a high school recognition program especially from a recognized cybersecurity authority (i.e., NSA).
    - Several of the criteria and dimensions resonated with the participants as essential to high school cybersecurity and worthy of basing recognition on.
    - A few of the participants noted the prestige that would come with recognition which would help with student recruitment, parental support for their children to take the course(s), and industry support for the program.

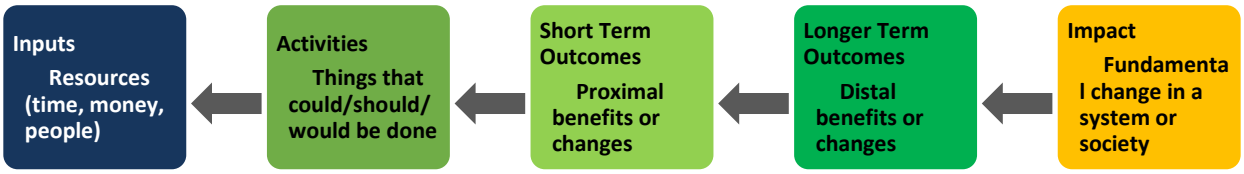
- The program's focus should be developmental (as opposed to static or recognition only) and emphasize continuous improvement (not a one and done approach).
    - The five-star model resonated with the focus group participants. None were concerned about a school earning fewer than five stars as they found value in the recognition with any number of stars.
    - Participants recognized value in having clear benchmarks of success to strive toward; a community of schools/teachers to share best practices; and an organizing body to coordinate and network among.
    - Several of the participants felt the criteria should be rigorous and seek to recognize truly exemplary programs that can demonstrate student success.

- The tension between how K-12 education operates in the United States (state and locally led) and establishing a national program with standard criteria means the program should be as flexible as possible.
    - As exemplified by participants from the four states involved in the focus groups, states differ on several factors that impact how individual schools can develop, staff, and grow cybersecurity courses and programs. For example, whether education is more centrally or state-controlled vs. local control; whether cybersecurity resides primarily in CTE departments vs. cybersecurity in computer science or business or other subject areas; and how teachers are determined to be qualified to teach cybersecurity (i.e, Florida teachers must earn an industry certification to be qualified to teach cybersecurity) vs. no specific cybersecurity-related qualifications.
    - The criteria would need to be flexible enough to recognize these differences and not penalize schools in states that cannot achieve a level due to systemic factors outside the school's control.

- The need to be aware of and account for environmental factors (enablers and barriers) to growing cybersecurity programs and pathways in establishing criteria for a recognition program.
    - Cybersecurity is not part of the "core curriculum" and in most states, there are no approved or recognized cybersecurity standards (yet).
    - As an elective course, teachers need to compete with other elective courses and recruit students into the program. This also means raising awareness and interest at the middle school level is important.
    - Staffing cybersecurity courses also means identifying teachers willing but perhaps not trained to teach cybersecurity. And cybersecurity is often not their only or primary subject area so they have other preps to consider.
    - Cybersecurity programs are typically resource intensive and can be challenging for less-resourced schools/districts to support in ways that might be considered exemplary.
    - With cybersecurity being offered in CTE programs in many states, Perkins requirements impact curricular and programmatic decisions.
    - The emphasis on industry certifications impacts the way cybersecurity is implemented and teacher training/preparation.

# Analysis

The analysis is structured using the theory of change model: inputs, activities, short-term outcomes, longer-term outcomes, and impact. The individual focus group summaries are in the appendix.




## Inputs

- School leadership and staff
- Program leadership and staff
- Time and money to collect data, generate reports, manage the process
- Incentives to participate

The primary inputs in a recognition program that have been identified by focus group participants and project leadership can be grouped into two categories based on key groups: 1) school leadership and staff and 2) program leadership and staff. Schools will have to spend resources (time and money) to collect required data, generate reports, and manage the application process. The program will need to hire or designate leadership and staff to administer the process, review applications, and coordinate programmatic activities. Depending on the size and scale of a recognition program with more and more high schools developing cybersecurity programs, the program staff and resources would need to be commensurate.

Another key input into a recognition program is the incentive to invest resources in participating in the program. The program depends on voluntary participation and thus must be valued by key stakeholders to invest time and money in participating. An incentive identified by the focus group participants included recognition from a cybersecurity authority which could increase awareness of their program, increase student enrollment, and community engagement. Another identified incentive was the potential of participating in a community of practice to share resources and develop professionally. Another incentive was to better understand the expectations of their cybersecurity program (which certifications are “best” to target, which educational tools and technologies “should” be used, etc.).

Other incentives identified by focus group participants included the prestige that could translate in an increase in student recruitment; increase in community / industry support and involvement; and involvement in a community of high school cybersecurity educators to share resources and best practices. Additional incentives included student scholarships, certification vouchers, funds for certification, summer boot camps, internships, and access to cyber ranges.

## Activities

- Schools to collect required data, generate reports, and manage the application process
- Recognition program staff to review reports and manage the application process
- Recognition program staff to determine and award recognition and any related activities (award ceremonies, press releases, etc.)

The primary activities of the program would include schools submitting the required information to determine eligibility and/or level of recognition; a process of reviewing the information communicating with the school representatives and determining eligibility; and awarding the recognition to the schools/program. Additional activities would include fundraising, marketing and communication, and coordination/management of the program.

## Outcomes

- Increased awareness of the cybersecurity program at the school/CTE center
- Contribute to student recruitment
- Increased student interest and potentially enrollment
- Increased community involvement and engagement
- Participation in a community of practice to share information and resources

Some of the potential outcomes identified by the focus group participants were the same described incentives. A recognition by a recognized authority in cybersecurity would lead to increased awareness of the cybersecurity program at the school/CTE center which could contribute to student recruitment and translate into more student interest and enrollment in the program, as well as more community involvement in the program. The recognition program could also help establish a community of practice whereby school staff could share information and resources with other recognized school programs.

## Impact

- Increase interest and awareness of high school cybersecurity education
- Serve as national standards or benchmarks for cybersecurity programs

A potential impact of a valued recognition program would be to heighten interest in high school cybersecurity education and lead to increased student enrollment, as well as community involvement. A national program offering a valued recognition to schools might increase public awareness, spur states to create cybersecurity standards, inform resourcing decisions both at the state and local levels, and generate momentum for more schools to offer cybersecurity programs.

Given the potential outcome of a recognition program providing clear benchmarks for high school cybersecurity education, the program could serve to standardize high school cybersecurity education in the United States. Currently there is not a recognized national standard for high school cybersecurity education. If the recognition is of value to schools across the United States, decisions made about the criteria by which high school

programs should meet including curricular and student success metrics would serve to inform the curricular decisions made by high school educators across the country.

# Implementation Questions

Although not the specific goal of the focus group discussions, bigger picture questions and recommendations were raised that the team felt important to capture. Some of these questions were posed to the subsequent focus group participants to provide further insight into the design and development of a recognition program.

- What agency or organization will be managing and giving credibility to the program?
- Who is paying for the school's effort to participate in gathering the data, reporting, and managing the process?
- How often will the recognized schools be re-evaluated?
- How many criteria are required for the school to be recognized?
- How will schools that have a single star in one category and five stars in another be graded?
- How could the integration of cybersecurity topics across the curriculum be recognized?
- How does a national program work across states when there aren't national standards?

## Recommendations

- Create a clear, specific mission statement to guide the program.
- Establish value statements that reflect the program's mission and the evaluation criteria.
- In terms of frequency for re-evaluation, a suggestion is to have a 3-year cycle.
- Be mindful of requiring criteria that can privilege some states/programs that have resources over those that do not.
- Incorporate other roles in the program beyond recognition. Ideas included:
    - Developing a community of practice between the recognized schools/programs to share resources and support.
    - Create a clear alignment of the recognition program to CAE institutions for college acceptance, scholarships, and dual-credit.
    - Support high school programs by offering student scholarships, teacher professional development, access to cyber ranges, and other mechanisms to offset some of the costs associated with running a cybersecurity program.
    - Becoming an intermediary between the cybersecurity program and the school's IT by providing a list of approved software and devices needed to run a cybersecurity program.
    - Organizing an annual meeting to develop community, share best practices, and as an opportunity for professional development.

## Criteria for Recognition Study - Attachment A

# Maryland Focus Group Summary

December 9, 2021

Six Participants:

- Diane Glasgow (Teacher)
- Elissa Hozore (Maryland State Department of Education)
- Kim Mentzell (Maryland Department of Commerce)
- Dianne O'Grady-Cunniff (Director at Maryland Center for Computing Education)
- Justin Serota (Computer Science Specialist at Anne Arundel Co Public Schools)
- James Hopper (Principal)

Below is a summary of the focus group participants' suggested revisions to the criteria:

- Curriculum & Instruction
    - Separate curriculum and instruction or revise instruction in the criteria to focus on how cybersecurity is taught so it is culturally-relevant and inclusive.
    - Extra-curricular activities should be a separate criterion and/or credit given for an extensive extra curricular cyber program.
    - Include descriptions in the curriculum criteria to include cultural relevance, depth, and breadth.

- Teacher Capacity & Quality
    - Remove this as a criterion because it is not within the scope of a recognition program to determine or evaluate (the state and the school determine teacher quality).
    - Remove hours of professional development (PD) because it is challenging to determine as not all PD is of the same quality or impact and depending on the teachers' background, some may not need as many hours of PD as others.
    - Replace PD hours with teacher certification, industry certification, or industry experience.

- Articulation
    - Combine this with the student success criterion.

- Outreach
    - Rename this category to Community Connections.
    - Add industry connections (# of hours), internships, shadowing, and partnerships to the levels.
    - Do not include descriptions for this criterion until level 3 or 4.
    - Add more description on what was meant by "collect letters."
    - Expand to include providing documented agreements or endorsements.

- Student Success
    - Reconsider the percentage pass rate as it might be too high.
    - Remove the aspects that require tracking students after they graduate as it is too challenging to do accurately.

- Infrastructure
    - Rename this criteria to “Sustainability” and include both teacher components and infrastructure here.
    - Include program growth data and/or capacity to grow.

In addition to the individual criteria, the focus group participants provided feedback on the structure of the rubric and its use:

- Instead of a rubric with columns and rows, create an inverted pyramid structure to indicate the progression of the levels for the identified criteria.
- Emphasize the developmental nature of the recognition program and indicate how to achieve a certain level at a certain level of quality.
- Review the “and/or” descriptions to determine whether they need to remain or can be revised to include either one (“and” or “or”).

## Florida Focus Group Summary

January 31, 2022

12 Participants:

- Ninafe Awong (Florida Department of Education CTE Director)
- Christopher Dunning (Principal - Pasco County)
- Jason Felt (Teacher - Pinellas)
- Cornelius Jackson (Teacher - Polk County)
- Emily Lamb (Learning Design Specialist - Pasco County)
- Jereme Monette (Teacher, Hillsborough)
- Sonia Samaroo (Teacher, Miami Dade)
- TJ Thoss (Teacher, Orange County)
- Michael Martucci (Teacher, Orange County)
- Diego Tibaquira (Professor, Miami Dade College)
- Scott Tumelty (Teacher - Pasco County)
- Candi Ring (University of South Florida)
- (James Welsh (University of South Florida - in attendance but did not participate in the focus group discussion))
- Below is a summary of the focus group participants’ suggested revisions to the criteria:
- Curriculum & Instruction:
    - Include internships and industry certifications.

    - Note: Florida has an applied framework for cybersecurity that has been mapped to the HSCCG so teachers using the framework would be able to easily demonstrate alignment.

- Recruitment of Students:
    - Add the use of exploratory courses to the list of recruitment activities starting in level 3.
    - Concern about recruitment being a criterion in that it is often in competition with other electives in another school.
    - Stress the importance of middle school to introduce cybersecurity and spark interest.
    - Concern about tracking retention and emphasizing dual enrollment because some students leave to take courses at community college, and this detracts from their enrollment numbers.
    - Include providing honors credit for cybersecurity courses in level 5.

- Teacher Capacity & Quality:
    - Concern about whether quality can be quantified through PD hours.

- Outreach:
    - Reduce the number of letters (6 is too many).
    - Define what outreach means and the activities that “count.”

- Student Success:
    - Clarify what the “or’s” mean and whether the school/teacher can decide which are appropriate or whether they can mix and match. A suggestion to have a “menu of options” and specify a targeted number for each level.
    - Identify the expected certifications. Florida determines “credentials of value” and provides a list of approved industry certifications.

- Infrastructure:
    - Recognize the challenges of working with the school’s IT department in building a cyber program (i.e., school firewall, IT policies, browser-based tool limitations).

In addition to the individual criteria, the focus group participants provided feedback on the implementation of the recognition program:

- There would need to be a tracking system to document data such as student enrollment and demographics, PD hours, etc.
- The recognition program could become an intermediary with the school's IT and provide approved software and devices needed to run a cyber program.

## Texas Focus Group Summary

March 15, 2022

10 Participants:

- Josh Beck (Teacher)
- Sean Maika
- Peggy Mica
- Mark Emry (Teacher)
- Tommy Gobber (Cyber.org)
- John Diaz Jr (Teacher)
- Brad Hebert
- Jennifer Schmerber (Teacher)
- Lisa Jones (Teacher)

Below is a summary of the focus group participants' discussion points related to the criteria:

- Curricular & Extra-Curricular Offerings
  - Discussed lack of national standards, the emphasis on certifications, and whether/how a national program could recognize an agreed upon list of standards or competencies.
  - Discussed whether to remove or define "digital citizenship"
  - Revise to explicitly state the extra-curricular offerings should be cyber-related.
  - Add student mentorships
  - Suggested broadening cybersecurity course(s) to include networking courses.

- Recruitment
  - Questioned whether inclusion is or should be part of the recruitment criterion; intentional steps toward removing barriers need to be articulated.

- Student Success
  - Report numbers not just % of taking and receiving certification exams.
  - Identify the appropriate certifications.
  - Provide clear targets for metrics.
  - Include volunteer work.

- Sustainability
  - Include a plan to provide teachers with PD.

- Articulation
  - Clarify the progression and difference between 3 stars and 4 stars.

- Community Connections
  - Add military.

In addition to the individual criteria, the participants provided feedback on the implementation of the recognition program.

- Incentives to participate in the program included offering students scholarships, certification vouchers, funds for certification, summer boot camps, internships, access to cyber ranges, etc.

- Additional incentives included teacher professional development, recognizing teachers as master teachers, funding for certification exams (preparation and taking the tests), and articulation agreements.
- Suggested a clear alignment of the recognition program to CAE institutions for college acceptance, scholarships, and dual-credit.
- Suggested creating a NSA designation for students, i.e., an NSA Jr. Analyst.

The participants also identified several concerns and potential barriers for a recognition program, including:

- Rural schools have particular challenges in implementing a cybersecurity program and in participating in a recognition program.
- Lack of resources: labs, infrastructure, budget, and cyber ranges.
- The cybersecurity teacher is usually the only one in their school and often in their district.
- Teacher time to participate in a program is limited.
- Administrator support might prevent participation.
- Recruiting and retaining qualified teachers.
- Some states have already defined a pathway/coherent sequence/number of credits that might not align to the criteria of a recognition program.
- “High school” definitions vary across states
- Dual-credit tends to be an extremely difficult process. Teachers do not have the time to make this happen.
- Missing criteria: teacher quality/capacity and curriculum and instruction.

## California Focus Group Summary

May 4, 2022

Thirteen Participants:

- Renee Hill (Superintendent, Riverside USD)
- Martin Rex (Superintendent, Moreno Valley USD)
- Forest DeRenzo (Executive Director of CTE, Riverside County Office of Education)
- Hillary Wolfe (Executive Director of College, Career, and Economic Development, Fontana USD)
- Gina Boster (Director, CTE at Corona Norco Unified School District)
- Matt Wells (Director at Mountain Desert Career Pathways)
- Donna Woods (Teacher)
- Koyett Miles (Teacher)
- John Nunes (Teacher)
- Ryan Augustine (Coordinator, Fontana USD)
- Ronald Weston (Coordinator, Riverside USD)
- Lori Fry (CTE Principal Coordinator, Riverside County Office of Education)
- Latoysha Brown (Director, College and Career Readiness, MVUSD)

Below is a summary of the focus group participants' suggested revisions to the criteria:

- Curricular & Extra-Curricular Offerings
    - Discussed what standards would be appropriate (industry, college, other guidelines?) and whether state or national level standards would be acknowledged.

- Recruitment
    - Suggestion to include equity in this criterion (focus on women and URM students with this criteria).

- Student Success
    - Questioned how success metrics, extracurricular, and community support are defined.
    - Suggested removing "consecutive" years as some students are not able to participate in courses consecutively due to scheduling conflicts.
    - Suggested including a list of qualifying certification exams.

- Sustainability
    - Questioned what "state of the art" meant and that this could be a barrier for some schools who have limited funding to purchase equipment.
    - Concerns about requiring a "dedicated" cybersecurity teacher as many schools cannot have teachers dedicated to one discipline.
    - Suggestion to make competencies a higher rating.

- Articulation
    - Questioned how the word "articulated" is being used.
    - Many felt this was too easy as CA requires this already.

In addition to the individual criteria, the participants provided feedback on the implementation of the recognition program.

- Validate the school program and potentially provide sustainability through funding.
- Helps to market the program, to attract students
- Aligned to CAE incentives, funding, and national networks
- Provide industry connections and support
- Bragging rights for recognition or model program designation
- Celebrating student success and student opportunities (scholarships, internships, externships)
- Recognized HS program connected to CAE for students that complete the program
- The participants also identified several concerns and potential barriers for a recognition program, including:
- Concerns about safety, vetting issues of websites, block and allow lists, district IT staff/risk management issues that would prevent participation in the program.
- Issues of teacher recruitment and retention – losing a cybersecurity teacher can end the program.

- Although equity and access were discussed as important to include, concerns about meeting this criterion where shared. Within CTE departments, for example, all programs are vying for the same limited number of students.
- Family support influences students and many families do not understand the language of cybersecurity so the conversations do not happen within the family.
- Adding another thing into education is often resisted.

In addition, a few questions were posed:

- How can cyber content be embedded across multiple pathways? This would be recognition of integration rather than a dedicated cybersecurity pathway.
- Is a 5-star level too easy to attain?
- Should digital citizenship be included? In CA, this is required of all schools already.

## Criteria for Recognition Study - Attachment B

| | ★ | ★★ | ★★★ | ★★★★ | ★★★★★ |
|---|---|---|---|---|---|
| **Curricular & Extra-Curricular Offerings** | No dedicated cybersecurity course offered.<br><br>Cybersecurity taught as a unit that is part of another course (ex. CS/IT/Business/Gen Ed.).<br><br>**OR**<br><br>Extra-curricular offering in cybersecurity (competition, club, workshop) offered less than 2 years or with less than 65 hours of contact time dedicated to cybersecurity.<br><br>Instruction is culturally-relevant and inclusive. | No dedicated cybersecurity course offered.<br><br>Cybersecurity taught as a significant unit that is part of another course or several smaller units in several courses (ex. CS/IT/Business/Gen Ed.).<br><br>**OR**<br><br>Extra-curricular offering in cybersecurity (competition, club, workshop) offered for 2 years or more or with more than 65 hours of contact time dedicated to cybersecurity.<br><br>Instruction is culturally-relevant and inclusive. | Dedicated cybersecurity course minimum of one semester being offered. Course meets ¼ of the learning objectives in the HSCCG.<br><br>**OR**<br><br>A robust cybersecurity extracurricular program offered for more than 3 years, that is the equivalent amount of contact time (~65 hours) and meets ¼ of the learning objectives in the HSCCG.<br><br>Instruction is culturally-relevant and inclusive. | Dedicated cybersecurity course minimum of one year. Meets 2/3 of the learning objectives in the HSCCG.<br><br>Instruction is culturally-relevant and inclusive. | Dedicated cybersecurity pathway. Meets all of the learning objectives in the HSCCG.<br><br>Instruction is culturally-relevant and inclusive.<br><br>Includes opportunities for students to participate in internships and/or receive industry certifications and/or participate in a robust cybersecurity extracurricular program (~65 contact hours). |

| | | | | | |
|---|---|---|---|---|---|
| **Recruitment** | Evidence of strategies to recruit a population representative of the school and/or to recruit students underrepresented in cybersecurity (i.e., female and students of color) into the extracurricular offering. | Vertical integration of cybersecurity taught as units in CS/IT/Business courses in a manner that meaningfully cumulates cybersecurity knowledge and introduces students to the larger career field of cybersecurity.<br><br>Evidence of strategies to recruit a population representative of the school and/or to recruit students underrepresented in cybersecurity (i.e., female and students of color) into the extracurricular offering. | Active recruitment of students into the cybersecurity course through at least 2 strategies (including exploratory units/courses, clubs, competitions, guest lectures, enrichment, parent education, guidance counselor involvement, and/or outreach to middle schools).<br><br>Evidence of strategies to recruit a population representative of the school and/or to recruit students underrepresented in cybersecurity (i.e., female and students of color). | Active recruitment of students into the cybersecurity course through at least 3 strategies (including exploratory units/courses, clubs, competitions, guest lectures, enrichment, parent education, guidance counselor involvement, and/or outreach to middle schools).<br><br>Evidence of strategies to recruit a population representative of the school and/or to recruit students underrepresented in cybersecurity (i.e., female and students of color). | Active recruitment of students into the cybersecurity course and pathway through at least 4 strategies (including offering honors credit, exploratory units/courses, clubs, competitions, guest lectures, enrichment, parent education, guidance counselor involvement, and/or outreach to middle schools).<br><br>Evidence of strategies to recruit a population representative of the school and/or to recruit students underrepresented in cybersecurity (i.e., female and students of color). |
| **Student Success** | Students have engaged in activities to demonstrate their cybersecurity knowledge (in competitions, CTFs, club-related events, etc.). | Students have engaged in activities to demonstrate their cybersecurity knowledge (in competitions, CTFs, club-related events, etc.).<br><br>**OR**<br><br>Students have conducted at least one cybersecurity-related research project (essay or poster) using multiple sources. | Students have completed a dedicated cybersecurity course in cybersecurity for two years. | Students have completed a dedicated cybersecurity course in cybersecurity for two years.<br><br>**AND**<br><br>The school can provide completion data on at least two metrics from a menu of options including:<br>• Number and % taking a cybersecurity certification exam | Students have completed a dedicated cybersecurity pathway.<br><br>**AND**<br><br>The school can provide completion data on at least three metrics from a menu of options including<br>• Number of completers in the pathway<br>• Number and % taking a cybersecurity |

| | | | | | |
|---|---|---|---|---|---|
| | | | | • Number and % receiving a cybersecurity certification<br>• Number and % planning to continue their cybersecurity education (additional high school courses or in college)<br>• Number and % planning to enter cyber workforce or enlist<br>• Number and % involved in additional cybersecurity education (extra-curricular activities, internships, job shadowing etc.)<br><br>**AND**<br><br>The school's specific strategies to maintain or improve the performance on the chosen metrics. | certification exam<br>• Number and % receiving a cybersecurity certification<br>• Number and % planning to continue their cybersecurity education (additional high school courses or in college)<br>• Number and % planning to enter cyber workforce or enlist<br>• Number % involved in additional cybersecurity education (extra-curricular activities, internships, job shadowing etc.)<br>**AND**<br><br>The school's specific strategies to maintain or improve the performance on the chosen metrics. |
| **Sustainability** | Assessment of cybersecurity needs for the school's infrastructure has been conducted and needs identified. | Plans for hardening the school's infrastructure have been developed, champions for each task have been identified and progress on implementing the plan has begun. | Cybersecurity plans are monitored, updated, and executed.<br><br>All cybersecurity course content and tools run reliably.<br><br>Educators have been provided appropriate professional | Students and educators have access to state-of-the-art educational tools to teach and learn cybersecurity.<br><br>Educators have participated in at least two professional development experiences and | Students and educators have access to state-of-the-art educational tools to teach and learn cybersecurity at school and home.<br><br>School has demonstrated commitment to continue offering |

| | | | | | |
|---|---|---|---|---|---|
| | | | development opportunities to be prepared to teach. | can demonstrate competence in teaching cybersecurity (certifications, PDU hours, etc.). | and grow cybersecurity education. Evidence may include hiring a cybersecurity teacher, increasing the budget for the cybersecurity program, prioritizing dual-credit courses, etc. |
| **Articulation** | | | The course is articulated to a minimum of one appropriate standard for preparing students for cybersecurity enrollment and/or employment. | The course is articulated to more than one appropriate standard for preparing students for cybersecurity enrollment and/or employment. | The pathway is articulated to appropriate standards for preparing students for cybersecurity enrollment and/or employment.<br><br>Steps are underway to establish dual/concurrent enrollment and/or placement credit with higher ed. |
| **Community Connections** | | | Evidence of community support from at least two organizations representing business and industry, higher education, nonprofit, military, etc. Evidence can include letters of support; letters of commitment to offer internship, job shadowing, etc. opportunities; endorsements; documented agreements / partnerships, etc. | Evidence of community support from at least three organizations representing business and industry, higher education, nonprofit, military, etc. Evidence can include letters of support; letters of commitment to offer internship, job shadowing, etc. opportunities; endorsements; documented agreements / partnerships, etc. | Evidence of sustainable (more than 2 years) of community support from at least three organizations representing business and industry, higher education, nonprofit, military, etc. Evidence can include letters of support; letters of commitment to offer internship, job shadowing, etc. opportunities; endorsements; documented agreements / partnerships, etc. |

# APPENDIX C

# CyberSupply: Securing the Workforce Study

**Report Authors:**
Dr. Melissa Dark, DARK Enterprises, INC.
Dr. Jenny Daugherty, DARK Enterprises, INC.
Nancy Stevens, DARK Enterprises, INC.

**Report Contributors:**
Chris Lannin, DARK Enterprises, INC.
Sabrina Smiley, DARK Enterprises, INC.

APPENDIX C

# CyberSupply: Securing the Workforce

## Executive Summary

The U.S. has over 769,000 unfilled cybersecurity jobs. Securing the cybersecurity workforce starts with building cybersecurity education and career pathways. CyberSupply reports on the **availability of cybersecurity and gateway-to-cybersecurity courses and pathways**, and the level of **access to cybersecurity courses and pathways for 9-12 students** in the U.S.

## Major Findings

### Cybersecurity Course Availability is Sparse

- 16% of U.S. regular public high schools have cybersecurity courses.
- 34% of medium-large, non-Title I schools have cybersecurity compared to 8% the very small-small[1], Title 1 schools.
- The 950 schools/CTE centers in the sample have 1799 cybersecurity courses. 46% only have a single cybersecurity course.
- There is significant variation by state. 61% of Virginia schools have cybersecurity courses and 8% of Arkansas schools do. Details on all 11 states are in the report.

### Student Access to Cybersecurity is Low

- ~3.7% of the student population (~566,000) have access to a cybersecurity course in high school.
- ~2.4% of the student population in very small-small, Title I schools have access to a cybersecurity course.
- ~4.7% of Asian students have access compared to ~3.8% URM and ~3.6% of White students.

### Gateway-to-Cybersecurity Course Availability is Moderate with Areas of Concern

- 58% of U.S. regular public high schools have gateway-to-cybersecurity courses.
- 74% of medium-large, non-Title I schools have cybersecurity compared to 42% the very small-small, Title 1 schools.
- The 3548 schools/CTE centers in the sample have 11127 cybersecurity courses. 26% only have a single gateway course.
- There is significant variation by state. 91% of Maryland schools gateway courses and 46% of Arkansas schools do. Details on all 11 states are in the report.

[1] Many very small-small schools are rural.

### Student Access to Gateway Courses is Moderate with Areas of Concern

- ~49% of the student population or ~7.5M students have access to a gateway in high school.
- ~33% of the student population Title I, smaller schools have access to a gateway course in high school.
- ~51.7% of Asian students have access to a cybersecurity course, compared to 49.0% URM students and ~48.4% of White students.

### Availability of and Access to Cybersecurity Pathways is Meager

- ~7.9% of U.S. regular public high schools have enough gateway and cybersecurity courses to offer a sequence that would include 2 gateway and 2 cybersecurity courses.
- ~1.0% of the student population in U.S. regular public high schools would have access to a cybersecurity pathway given the number of courses available.

# Overview and Methodology

One of the five research projects was a landscape study of existing High School cybersecurity in the United States. This was a descriptive research study characterizing cybersecurity and computing education in the population of public high schools and CTE centers in the U.S. The landscape study allowed the research team to a) determine the extent to which cybersecurity is embedded in U.S. high schools, b) consider how U.S. schools can leverage their computer science (CS) and information technology (IT) gateway courses to create cybersecurity pathways, and c) gauge the number of schools that might be ready for a designation as a "Program/School of Excellence."

Data were collected from 12 states. However, due to a lack of publicly available data, Alabama was dropped from the study. The remaining states in the sample include:

7. Arkansas
8. Colorado
9. Florida
10. Georgia
11. Illinois
12. Maryland
7. Ohio
8. South Carolina
9. Texas
10. Utah
11. Virginia

States were selected based on geographic diversity, diversity of schools by demographic factors such as school locale and size, and the diversity of the state population and enrolled students by race/ethnicity.

## Population and Sample

There are 13,918 regular[2] public schools serving students in grades 9-12 and 1210 CTE centers[3] in the United States (National Center for Educational Statistics). CTE centers provide career/technical education (CTE) part-time to students who receive all or most of their academic instruction at their home high school.

This study collected data from 5,915 regular public high schools, representing a sample 42.5% of all of the regular public schools in the U.S. In addition, data were collected from 192 CTE centers, representing a sample 15.8% of the CTE centers in the U.S. Based on the sample size, the confidence level for the regular public school data is >99.99% and for the CTE centers is 90%.

## Research Questions

The research answered the following primary questions to answer the overarching question for the larger study: How many schools currently would be eligible for a designation?

### Availability of Courses

1. What percentage of schools and CTE centers have cybersecurity courses, and computing courses that would be foundational to cybersecurity (foundational courses in this study are called gateway courses)?
2. Are there differences in availability by state, Title I status, size, and locale?
3. How many courses are offered by type (gateway, non-gateway, cybersecurity)?

### Attendance and Access

1. How many students attend the schools & CTE centers with gateway and cybersecurity courses?
2. Are there attendance differences by state?
3. Are there attendance differences by race/ethnicity?
4. Given availability levels along with other limitations (limited teachers, computer labs, and available hours), how many high school students have access to gateway computing and cybersecurity courses?
5. Are there differences in access by state?
6. Are there differences in access by student race/ethnicity?

### Designation

1. In what pathways are gateway and cybersecurity courses located in these states and how many schools would be eligible for designation?
2. What would be a recommended alternative to designation CTE pathways and how many schools would be eligible?
3. How many schools would be eligible for designation if the net were cast wider?

[2] Does not count vocational, SPED, and alternative schools.

[3] U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," 2009-10 through 2019-20. (Table 216.10 November 2021)

## Data Collection

Data sources included the Common Core of Data (CCD) from the National Center for Education Statistics. The data on enrollment, race/ethnicity, free/reduced lunch, Title I status, size[4] and locale were gathered from NCES. The data on course availability were gathered from publicly available websites.

A note on overreporting: these data reflect what the school website reported as *available* courses. The fact that a course is listed in the school catalog does not mean the course was actually offered. Courses are canceled due to low enrollment, which happens most often with elective courses. Computer science is an elective course in 90% of the U.S. states (State of Computer Science Education 2022[5]). Likewise, cybersecurity is an elective course. Course offerings for electives are dependent upon student interest and teacher availability, hence the likelihood of overreporting.

CyberSupply course availability data is reported for all 5,915 schools and 192 CTE centers. We then narrow in on course availability in the 4,441 9-12 schools. Student demographic access data (race/ethnicity) are only available in NCES for students who attend the 4,441 9-12 schools.

## Schools

Of the 6,107 institutions in the data set:

- 5,915 are schools and 192 are CTE centers (97% and 3% respectively)
- 3,737 of the 5,915 schools are Title I (63%)
- 4,441 schools are 9-12 schools (75%)
    - 2,657 of the 9-12 schools are Title I (60%)
    - 3,064 of 9-12 schools are not rural and 1,377 are rural (69% and 31% respectively)
    - 1,749 of the schools have fewer than 600 students (39%); 917 schools have 600-1,200 students (21%); 997 have 1,201-2,000 students (22%); and 778 have more than 2,000 students (18%).
    - The rural schools tend to be small; 61% of the rural schools have <600 students compared to 6.6% of the rural schools with >2,000 students. In contrast, there is a more even distribution of school size among the urban/suburban/town schools where 30% of the urban/suburban/town have <600 students and 23% of the urban/suburban/town have >2,000 students.

[4] Enrollment numbers were gathered from NCES and then CyberSupply used the number of students enrolled to categorize the school as very small (<600), small (601-1200), midsize (1201-2000), and large (>2000).
[5] https://advocacy.code.org/stateofcs

The distribution of schools across the states is shown in the table and figure below. As can be seen, Texas has the most schools in the sample (1,651, 27%) and Utah has the least (199, 3%).

| State | Total | Schools | CTE Centers |
|---|---|---|---|
| | N | N | N |
| **AR** | 324 | 302 | 22 |
| **CO** | 385 | 384 | 1 |
| **FL** | 571 | 566 | 5 |
| **GA** | 452 | 452 | 0 |
| **IL** | 761 | 737 | 24 |
| **MD** | 225 | 211 | 14 |
| **OH** | 912 | 849 | 63 |
| **SC** | 286 | 241 | 45 |
| **TX** | 1659 | 1651 | 8 |
| **UT** | 205 | 199 | 6 |
| **VA** | 327 | 323 | 4 |
| **Total** | 6107 | 5915 | 192 |

***Table 1.*** Number of Regular Public Schools and CTE Centers by State

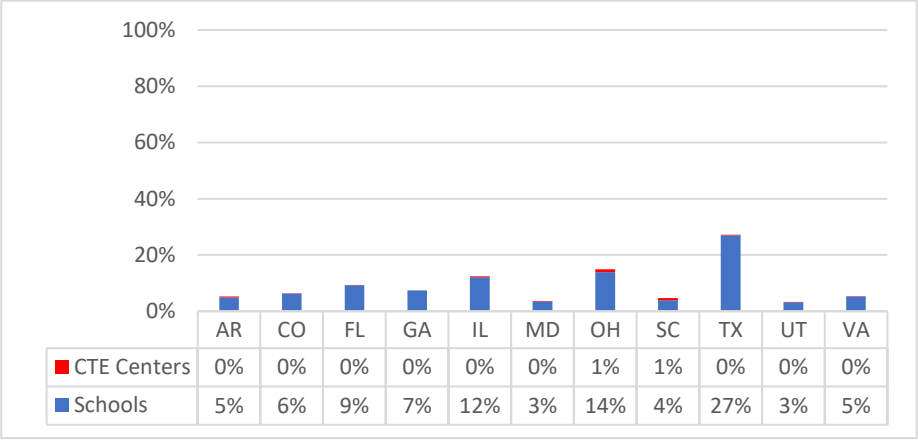



***Figure 1.*** Percentage of Regular Public Schools and CTE Centers by State

There is variation in 9-12 schools by state. Only 49% of Arkansas schools are 9-12, leaving 51% that are K-12 and 6-12. In contrast, Maryland has the highest percentage of 9-12 schools (92%). This is relevant because the K-12 and 6-12 schools have fewer computing, gateway computing and cybersecurity courses.

| State | Number of 9-12 Schools | % of 9-12 Schools in Each State |
|---|---|---|
| **AR** | 149 | 49% |
| **CO** | 246 | 64% |
| **FL** | 437 | 77% |
| **GA** | 396 | 88% |
| **IL** | 610 | 83% |
| **MD** | 195 | 92% |
| **OH** | 624 | 73% |
| **SC** | 206 | 85% |
| **TX** | 1188 | 72% |
| **UT** | 113 | 57% |
| **VA** | 277 | 86% |

***Table 2.*** Distribution of 9-12 Regular Public Schools by State

While 63% of all schools and 60% of all 9-12 schools are Title I, there is variation by state. 89% of all Arkansas schools are Title I and 87% of 9-12 schools in Arkansas are Title I. Arkansas has the highest number of Title I schools in their state (270/302 = 89%) and Virginia has the lowest percentage at 3%. Other states higher in Title I schools include Texas, Florida and Illinois. And other states toward the lower end include Colorado, Utah and South Carolina.

| State | All Grade Bands Title I | 9-12 Schools Title I |
|---|---|---|
| **AR** | 89% | 87% |
| **CO** | 24% | 13% |
| **FL** | 79% | 79% |
| **GA** | 53% | 49% |
| **IL** | 79% | 80% |
| **MD** | 44% | 43% |
| **OH** | 61% | 58% |
| **SC** | 20% | 17% |
| **TX** | 84% | 81% |
| **UT** | 26% | 12% |
| **VA** | 3% | 3% |

***Table 3.*** Percent of Title 1 by Grade Band and 9-12 Regular Public Schools by State

While 31% of all schools in the dataset are rural and 60% of the schools are very small (<600 students) or small (<600-1200 students), there is variation by state. Arkansas has the highest percentage of rural schools (52%), as well as the highest percentage of smaller schools (86%). Ohio also has a large percentage of smaller schools (85%), but only 34% rural schools (middle of the pack). Florida is the opposite of Arkansas; only 15% of the Florida schools are rural and only 29% are very small or small.

| State | Rural | <600-1200 |
|---|---|---|
| **AR** | 52% | 86% |
| **CO** | 29% | 65% |
| **FL** | 15% | 29% |
| **GA** | 34% | 51% |
| **IL** | 28% | 72% |
| **MD** | 19% | 45% |
| **OH** | 34% | 85% |
| **SC** | 42% | 33% |
| **TX** | 34% | 58% |
| **UT** | 14% | 40% |
| **VA** | 35% | 47% |

***Table 4.*** Percent of Rural and Small Regular Public Schools by State

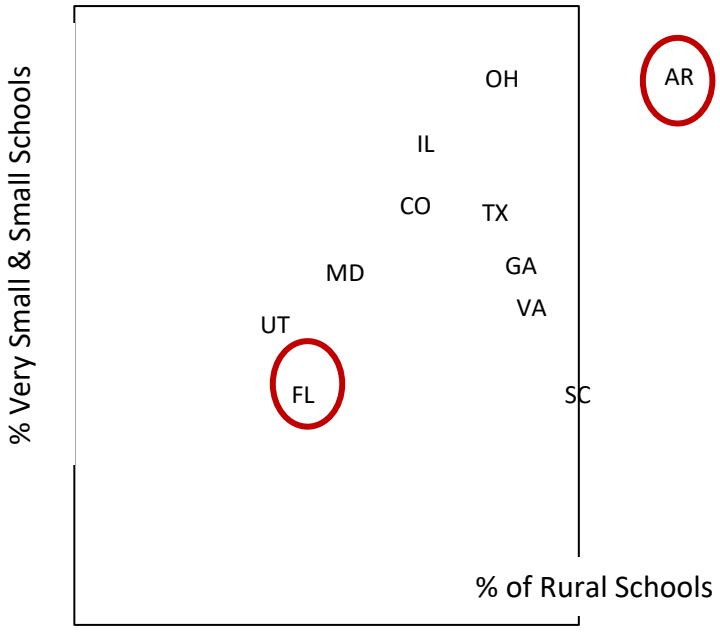



***Figure 2.*** SEQ Figure * ARABIC 2. Percent of Very Small/Small Schools to Percent of Rural Schools by State

## Courses

The data collected from school websites was the availability of computing courses (i.e., whether the course was listed as potentially being offered). Courses were coded into four categories:

1. Gateway computing courses
2. Non-gateway computing courses
3. Cybersecurity
4. None/Undetermined

What is a "gateway course"? In some contexts, gateway courses are courses that a large number of students pass through, such as English, algebra, or biology. This is not the definition of gateway courses for this study. In this study, gateway courses are defined as introductory courses that teach necessary prerequisite knowledge that set students up for success, both during their academic career and their professional lives. When students don't do well in these courses, they are embarking down an academic pathway with fewer resources. Without the foundation provided in the gateway courses, students will lack the knowledge to do well in cybersecurity. The substantive purpose for gateway courses is giving students the best opportunity to get interested in and ready for further learning. Gateway courses have both a recruiting and retention emphasis – getting students into, and keeping them in, cybersecurity.

To code courses, CyberSupply gathered initial data from four states and created a master list. The course list was analyzed using curricular guidelines at the college level (the CAE Knowledge Units and the ACM CSEC guidelines), as well as other seminal works in the field such as the NICE Workforce Framework. Courses were then coded as gateway or non-gateway[6]. And finally, the gateway courses were further coded as CS gateway or IT gateway. The final list consists of the following 26 courses. Yellow denotes CS gateway (the first ten courses listed), orange denotes IT gateway (the following 4 courses listed) and blue denotes non-gateway computing courses (the last 12 courses listed).

Gateway or Non-Gateway Computing Course Codes:

1. CSP/AP CSP
2. CSA/AP CSA
3. Computer Science Discoveries
4. Computer Science Essentials
5. Exploring Computer Science
6. Introduction to Computer Science
7. Linux
8. Programming I
9. Programming II
10. Programming III
11. IT Fundamentals
12. Networking I
13. Networking II
14. Networking III
15. Computer Applications
16. Computer Management and Support
17. Database
18. Digital Media
19. Game Design I
20. Game Design II
21. Mobile Applications
22. Robotics
23. Web Design I
24. Web Design II
25. Capstone I
26. Capstone

[6] Coding of courses as gateway or non-gateway was at the discretion of the authors. We used our experience and expertise in the field to make these judgments, which are solely the authors' and may differ from the opinions of others.

## Students

There were 5,383,544 high school students enrolled at these 5,915[7] regular public schools. This represents ~35% of the total high school students in the U.S.

Demographic data were available for the 4,928,516 high school students who attend **9-12 schools**. Racial/ethnic composition is shown.

| Racial/Ethnic Category | # | % | % Nationally |
|---|---|---|---|
| American Indian | 15541 | 0.3% | 1.0% |
| Black | 925895 | 18.8% | 15.0% |
| Hispanic/Latinx | 1489219 | 30.2% | 28.0% |
| Native Hawaiian/Pacific Islander | 10144 | 0.2% | <1% |
| Total URM | 2440799 | 49.5% | 44.0% |
| White | 2103299 | 42.7% | 47.0% |
| Asian | 218897 | 4.4% | 5.0% |
| Multiracial | 165464 | 3.4% | 4.0% |
| Missing | 57 | 0.0% | |
| Total | 4,928,516 | 100.0% | 100.0% |

***Table 5.*** Distribution of Students by Race/Ethnicity

# Results

## Availability

### RQ 1. % of Schools with Courses

3,548 regular public schools and CTE centers (58%) have gateway computing. 529 schools and CTE centers (9%) only have computing courses that are non-gateway for cybersecurity. And 2,030 (33%) schools did not have computing courses or lacked course information accessible on a website and were coded as undetermined.

| **Computing Course Type** | **Frequency** | **Percent** |
|---|---|---|
| Gateway Computing | 3548 | 58% |
| Only Non-Gateway Computing | 529 | 9% |
| No Computing/Undetermined | 2030 | 33% |
| **Total** | **6107** | **100%** |

***Table 6.*** Distribution of Computing Course by Type

[7] In NCES, CTE centers do not have enrollments. The students are counted in their home schools.

Further breakdown of gateway computing courses shows 2,168 schools with only CS gateway courses, 284 with only IT gateway courses, and 1,096 with both CS and IT gateways[8]. Given the nature of the cybersecurity discipline, it could be argued that *only* the 1,096 schools with both CS and IT courses truly have the foundation for cybersecurity. While 1,096 schools have both CS and IT gateway courses, this does not mean that the CS and IT courses are integrated into a cybersecurity pathway, a point that is covered in more detail in the section entitled RQ 3. Courses Offered.

| Computing Course Offered | Frequency | Percent |
|---|---|---|
| Only CS Gateway | 2168 | 35% |
| Only IT Gateway | 284 | 5% |
| Both CS and IT Gateway | 1096 | 18% |
| **Total** | **3548** | **58%** |

***Table 7.*** Distribution of CS and IT Gateway Courses Offered

Table 8 shows that 950 schools (16%) in the study had cybersecurity. During the coding of courses, course descriptions were reviewed. However, these are often very short and uninformative; therefore, a review of the courses for rigor/quality was not possible.

| Course | Frequency | Percent |
|---|---|---|
| Cybersecurity | 950 | 16% |

***Table 8.*** Percent and Frequency of Cybersecurity Courses Offered

## RQ 2. % of Schools with Courses by State, Title I Status, Size, and Locale

### By State

Figure 4 shows course offerings by state using the same three categories: gateway, non-gateway, and none/undetermined. In addition, it shows how each state compares to the average. Gateway courses are displayed in orange, non-gateway in blue, and none/undetermined in gray.

[8] Of note, the CyberSupply findings of 53% of schools with CS gateway courses (35% + 18%) is consistent with another major report in this area, i.e., the 2022 State of CS Report, which reports that 53% of U.S. high schools now offer a foundational computer science course.

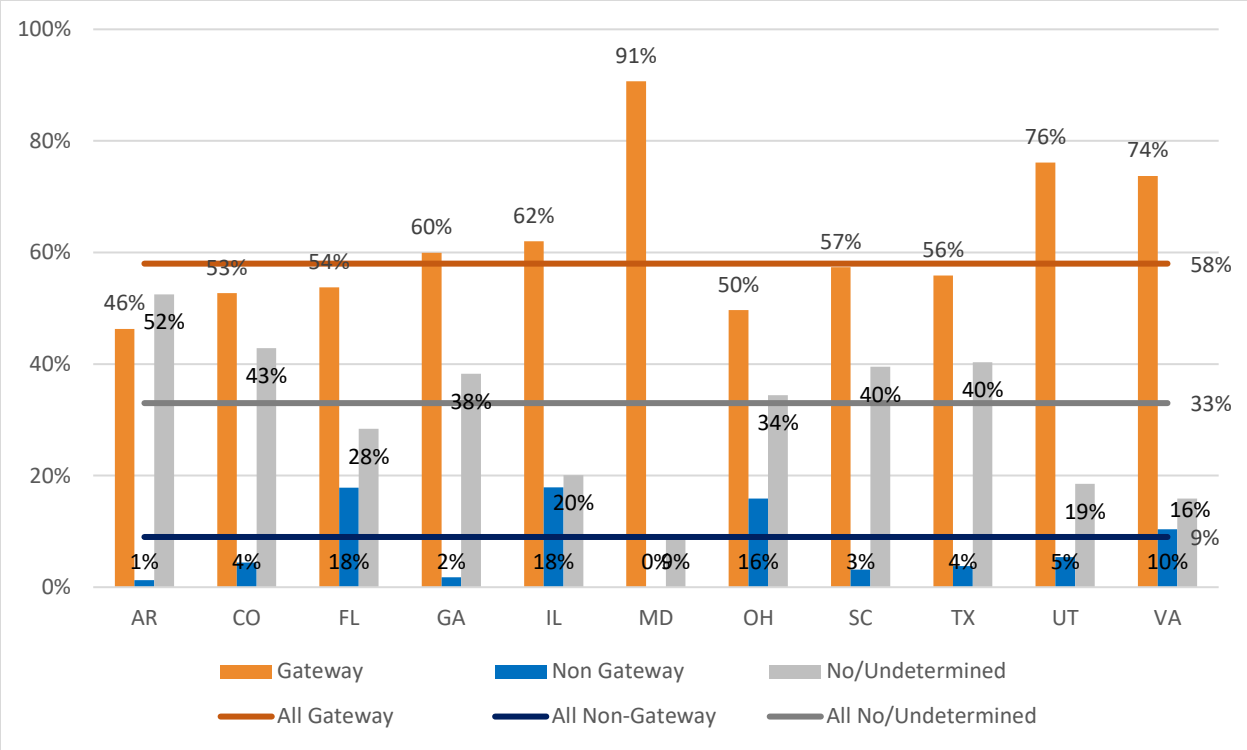



***Figure 4.*** Distribution of Gateway, Non-Gateway Computing, None/Undetermined Course Offerings by State

58% of all schools have gateway computing, as shown by the dark orange line. The % of schools with gateway courses by state is shown by the lighter orange bars. Maryland leads with 91% of its schools and CTE centers having gateway computing courses available. Virginia and Utah are nearing 80% of their schools with gateway computing courses. Georgia and Illinois are also above the 58% average. The states below the average include Arkansas, Colorado, Florida, Ohio and Texas.

In the sample, 33% of the schools had no computing or were undetermined. This is shown by the dark gray line. The lighter gray bars show how each state compares to the average and to each other. Arkansas has the highest percentage with 52% of Arkansas schools lacking computing (or were undetermined). Other states above average with regard to no/undetermined computing include Colorado, Georgia, Ohio, South Carolina and Texas.

9% of schools in the sample have computing, but ONLY have non-gateway courses, i.e., courses that would not be foundational for cybersecurity (as shown by the dark blue line). The blue bars show the same statistic for each state. The states with a higher-than-average percentage of schools with only non-gateway courses include Florida, Illinois, Ohio, and Virginia.

Ohio has more schools than Arkansas with computing (66% vs. 46%), but 16% of Ohio schools have ONLY non-gateway courses compared to 1% of Arkansas schools that have ONLY non-gateway courses. Florida and Illinois also have a noticeable number of schools with ONLY non-gateway courses (18% each).

Figure 5 shows the cybersecurity course offerings by state. 16% of the 6,107 schools and CTE centers in the sample have cybersecurity courses, but as is evident in the chart, Virginia is an outlier at 61%. Virginia offers cybersecurity courses across multiple program areas, such as Health, Manufacturing, Agriculture, Marketing, etc. with the intent of customizing a course for all career clusters. Without Virginia, the average number of schools with cybersecurity courses drops to 13%. The remaining states are well below 61% with the next highest percentage being South Carolina having 19% of its schools offering cybersecurity, followed by Maryland with 18% of its schools and Utah with 14%. Three states (Colorado, Florida, and Georgia) have 11% of their schools offering cybersecurity. And Illinois and Ohio both with 9% of their schools respectively. Arkansas rounds out the states with 8% of their schools offering cybersecurity.

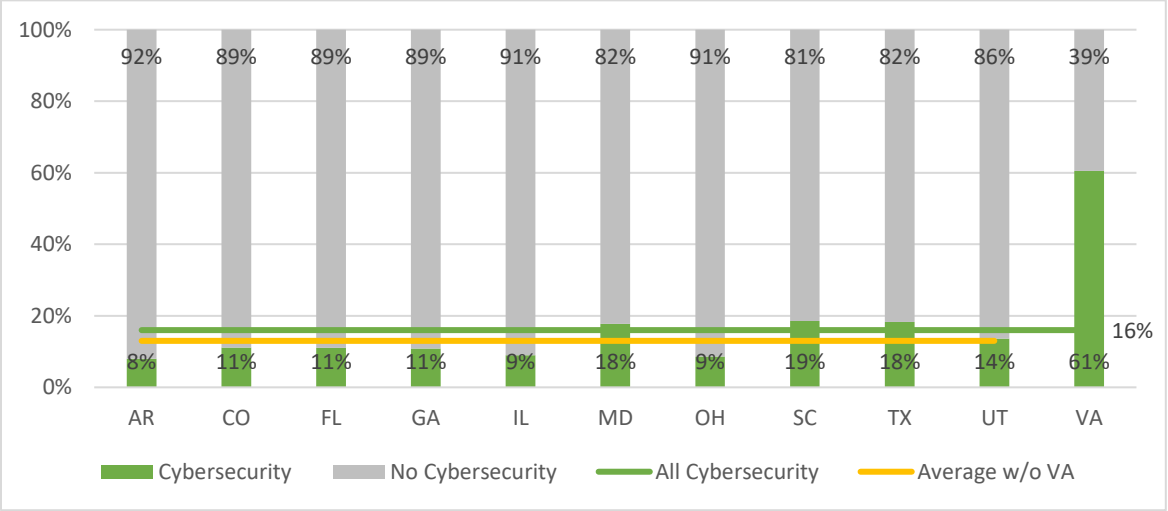



***Figure 5.*** Percent of Schools Offering Cybersecurity by State

## By Title I Status

52% of the 3,737 Title I Schools have gateway computing compared to 68% of the 2,179 non-Title I schools as shown in Figure 6. Interestingly, 9% of Title I schools have ONLY non-gateway courses compared to 8% of the non-Title I schools with ONLY non-gateway. A designation that requires gateway computing will advantage non-Title I schools.

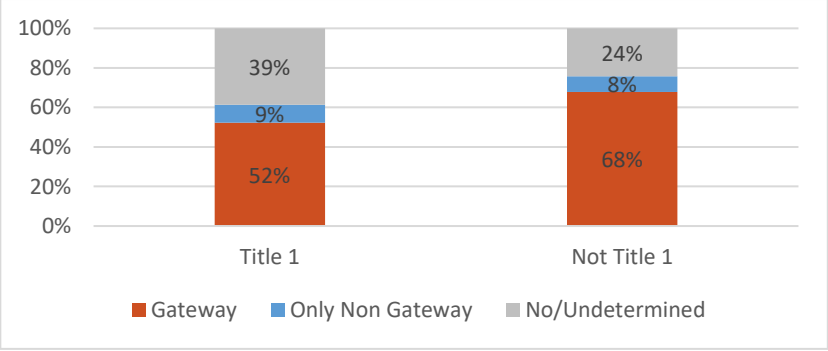



***Figure 6.*** Percent of Gateway, Non Gateway, and None/Undetermined Courses by Title 1 Status

While 22% of all non-Title I schools have a cybersecurity course, only 11% of Title I schools do as shown in Figure 7. Virginia has few Title I schools (3%) and several schools with cybersecurity (61%). When Virginia schools are removed from the data set, the Non-Title I schools with cybersecurity drops to 15%, while the Title I schools hold at 11% and still fall short of what is offered in Non-Title I schools.

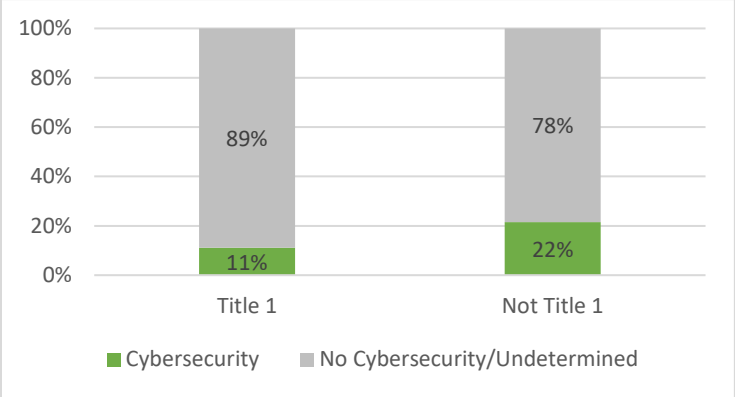



***Figure 7.*** Percent of Cybersecurity Courses by Title 1 Status

## By School Size and Locale for 9-12 Schools

CyberSupply looked at the availability of courses by school size and locale factors for 9-12 schools (n=4,441). Figure 8 shows that 95% of the 9-12 schools with >2000 students have computing and most of those schools (92%), have gateway computing courses. In contrast, only 44% of the very small schools (<600 students) have gateway computing courses. The trendline is clear, the smaller the school, the less likely it is to have computing. However, it is interesting that there is an opposite pattern with regard to having ONLY non-gateway courses. As can be seen, 12% of the schools with <600 students have ONLY non-gateway computing courses. This drops to 7% for schools with 600-2000 students and then to 3% for schools with >2000 students.

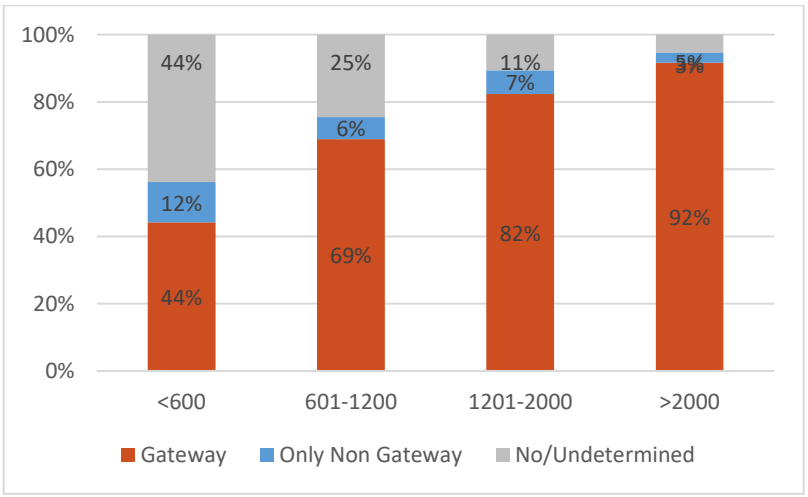



***Figure 8.*** Percent of Gateway, Non Gateway, and None/Undetermined Courses by School Size

The availability of cybersecurity courses follows a similar pattern where the larger the school in terms of student body, the more likely it is to offer cybersecurity as shown in Figure 9. The table below shows that 35% of large schools (>2000 students) offer cybersecurity; 25% of medium size schools (1201-2000 students); 16% of small schools (601-1200 students); and 8% of the very small schools (<600 students).

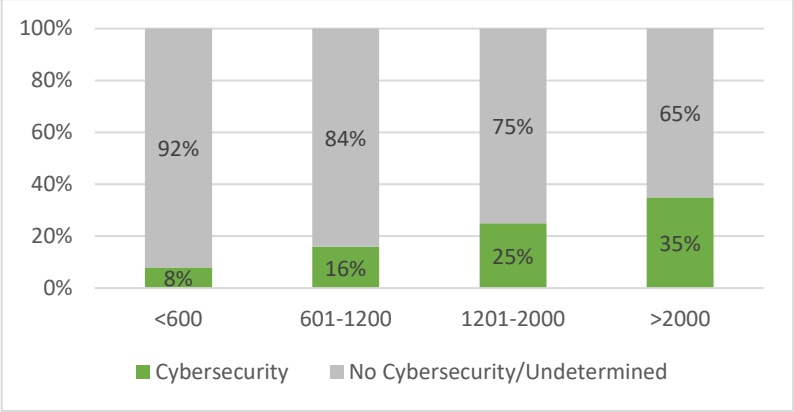



***Figure 9.*** Percent of Cybersecurity Courses by School Size

In terms of locale (rural vs. city/suburb/town), 54% of rural schools have gateway computing compared to 71% of schools that are not rural as shown in Figure 10. Here we see the same phenomenon with the non-gateway courses; 12% of rural schools that have computing ONLY have non-gateway courses, but only 7% of the city/suburb/town schools have ONLY non-gateway. Many, but not all, of these rural schools with ONLY non-gateway courses are also the small schools shown above.

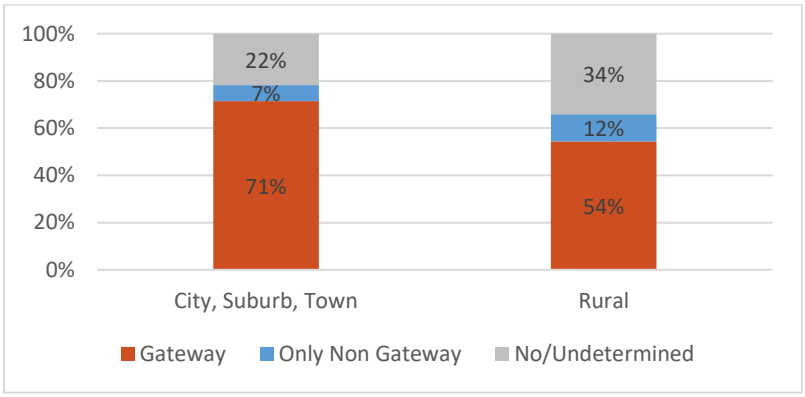



***Figure 10.*** Percent of Gateway, Non Gateway, and None/Undetermined Courses by Locale

Figure 11 shows a smaller percentage of rural schools with cybersecurity compared to city/suburban/town schools, 14% vs. 20% respectively.

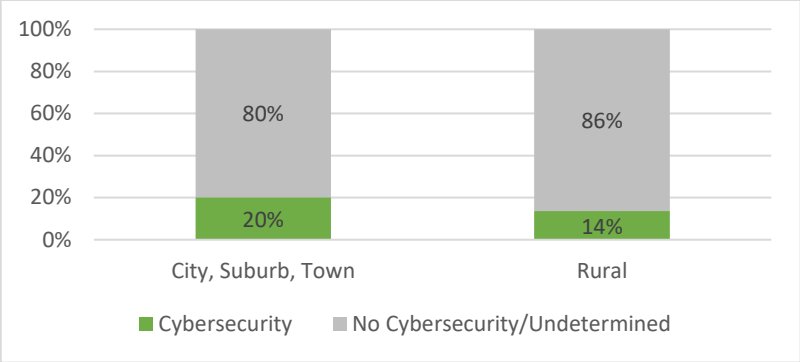



***Figure 11.*** Cybersecurity Courses by Locale

Because size and locale intersect, we looked at the availability of courses at the intersection as shown in Figure 12. Size, not locale, is the dominant factor. As size increases, so do gateway and cybersecurity courses, regardless of locale. In fact, rural large schools have more gateway computing than city/suburb/town large schools (95% vs. 91%). 35% of large schools have cybersecurity regardless of locale. And as size increases, the percentage of schools with ONLY non-gateway courses decreases for both locales.

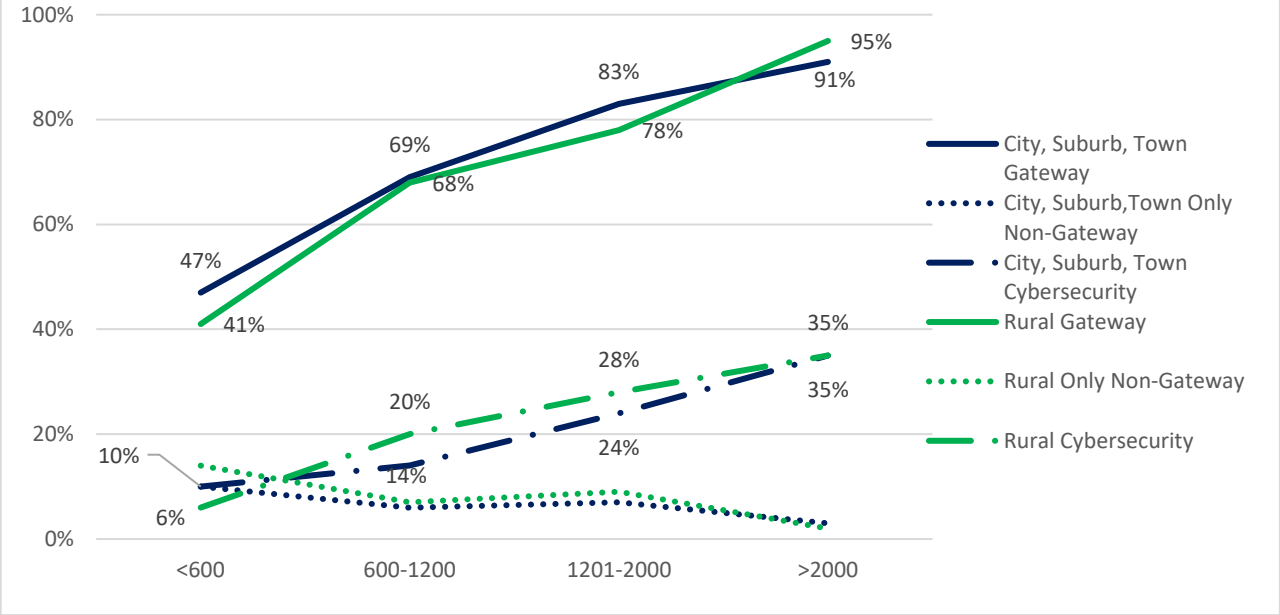



***Figure 12.*** Percent of Gateway vs. Non-Gateway by Size and Locale

## RQ 3. Courses Offered

A total of 17,317 computing courses and 1,799 cybersecurity courses were identified as shown in Table 9.

| Computing Course Type | Frequency | Percent |
|---|---|---|
| Gateway | 11127 | 64% |
| Non-Gateway | 6190 | 36% |
| **Total** | **17,317** | **100%** |

***Table 9.*** Distribution of Computing Courses

A breakdown of the 11,127 CS gateway courses and IT gateway courses is shown in Table 10.

| Computing Course Type | Frequency | Percent |
|---|---|---|
| CS Gateway | 8681 | 50% |
| IT Gateway | 2446 | 14% |
| **Total** | **11,127** | **64%** |

***Table 10.*** Distribution of CS and IT Gateway Courses

Table 11 below gives a more granular view of courses by category (CS gateway, IT gateway, non-gateway). In terms of CS Gateway courses, the largest percentage of courses offered were Computer Science Principles (CSP) or Advanced Placement CSP (AP CSP) courses at 21%, followed by three courses with 17% of offerings, which included Advanced Placement Computer Science A (AP CSA), Introduction to Computer Science, and Programming I. The largest percentage of IT gateway course offerings was IT Fundamentals at 42%, followed by Networking I (42%) and Networking II (17%). The largest percentage of Non-gateway computing course offerings was Digital Media and Web Design both at 19%.

| | | Total | % | Cumulative % |
|---|---|---|---|---|
| Gateway Computer Science | AP CSP or CSP | 1864 | 21% | |
| | AP CSA | 1473 | 17% | |
| | Introduction to Computer Science | 1518 | 17% | |
| | Computer Science Discoveries | 303 | 3% | |
| | Computer Science Essentials | 229 | 3% | |
| | Exploring Computer Science | 235 | 3% | |
| | Linux | 41 | 0% | |
| | Programming I | 1508 | 17% | |
| | Programming II | 1073 | 12% | |
| | Programming III | 437 | 5% | **50%** |
| | **Total Gateway Computer Science** | **8,681** | **100%** | |
| Gateway Information Technology | IT Fundamentals | 1038 | 42% | |
| | Networking I | 797 | 33% | |
| | Networking II | 426 | 17% | |
| | Networking III | 185 | 8% | |
| | **Total Gateway IT** | **2,446** | **100%** | **14%** |
| Non-Gateway | Computer Management and Support | 504 | 8% | |
| | Database | 76 | 1% | |
| | Digital Media | 1168 | 19% | |
| | Game Design/Development I | 892 | 14% | |
| | Game Design/Development II | 285 | 5% | |
| | Mobile App Design/Development | 271 | 4% | |
| | Robotics | 745 | 12% | |
| | Web Design | 1161 | 19% | |
| | Web Design II | 566 | 9% | |
| | Capstone Course I | 417 | 7% | |
| | Capstone Course II | 105 | 2% | **36%** |
| | **Total Non-Gateway** | **6,190** | **100%** | |
| | **Total** | **17,317** | | **100%** |

***Table 11.*** Distribution of Computing Courses by Course Title and Category

The 950 schools with cybersecurity have 1,799 cybersecurity courses. Table 12 provides the number of cybersecurity courses by title of course. Of note, 437 of the 950 schools have a single cybersecurity course, leaving 513 schools/CTE centers that have two or more courses. The largest percentage of cybersecurity courses are Cybersecurity 1 at 47% followed by a Cybersecurity II course at 14% and Network Security at 11%.

| Cybersecurity Course Titles | Total | % |
|---|---|---|
| Cybersecurity I | 852 | 47% |
| Cybersecurity II | 255 | 14% |
| Cybersecurity III | 101 | 6% |
| Principles of Cybersecurity | 29 | 2% |
| Network Security | 200 | 11% |
| Cyber Forensics | 104 | 6% |
| Cyber Ops | 63 | 3% |
| Advanced Cyber Forensics | 159 | 9% |
| Other | 36 | 2% |
| **Total** | **1,799** | **100%** |

***Table 12.*** Distribution of Cybersecurity Courses by Title of Course

### Attendance and Access

Close to 5.4 million high school students attend these 6,107 schools and CTE centers, which is about 35% of high school students in the U.S. Of the 5.4 million, nearly 5 million attend 9-12 schools. This is pointed out here because student demographic data (race/ethnicity) are not available in NCES for high school students who attend schools in the 6-12 grade band, K-12 grade band, and CTE centers. The following data only pertains to students attending 9-12 regular public high schools in the U.S.

## RQ 4. Attendance at Schools with Gateway & Cybersecurity Courses

Table 13 shows the percent of students attending schools that offer gateway computing, only non-gateway computing, no/undetermined computing, and cybersecurity courses.

| | Total | Gateway Comp | Only Non-Gateway Comp | No/Undetermined Computing | Cybersecurity |
|---|---|---|---|---|---|
| **All HS** | 4928516 | 3971898 | 280929 | 675689 | 1294908 |
| **Attendance** | | 81% | 6% | 13% | 26% |

***Table 13.*** Attendance by Computing Type and Cybersecurity Courses Offered

When attendance is further broken down by Gateway Computing (both CS and IT), only CS Gateway or only IT gateway, the percentages are 30% of students attend a school with both CS and IT gateway courses, 47% attend a school with only CS gateway, and 4% attend a school with only IT gateway courses as shown in Table 14.

| | Total | Both CS and IT Gateway | Only CS Gateway | Only IT Gateway |
|---|---|---|---|---|
| **All HS** | 4928516 | 1467327 | 2321103 | 183468 |
| **Attendance** | | 30% | 47% | 4% |

***Table 14.*** Attendance by Gateway Computing Type

Whereas 58% of the schools have gateway computing, 81% of the students attend these schools as shown in Table 15. This is because gateway courses are more available in larger schools. 92% of large schools have gateway computing compared to 44% of very small schools. And whereas 9% of all schools have ONLY non-gateway computing, 6% of the students attend these schools. This is because non-gateway courses are more available in the very small and small schools. And finally, while only 16% of schools have cybersecurity, 26% of students attend these schools. Again, the difference is due to the fact that larger schools have more gateway and cybersecurity courses.

| | % Schools with Availability | % Students in Attendance |
|---|---|---|
| **Gateway** | 58% | 81% |
| **Only non-gateway** | 9% | 6% |
| **No/undetermined Computing** | 33% | 13% |
| **Total** | 100% | 100% |
| **Cybersecurity** | 16% | 26% |

***Table 15.*** Schools with availability of Computing Courses Compared to Students in Attendance

Table 16 shows the percentage of schools that have CS and IT gateway, CS gateway only, and IT gateway only courses available by the percent of students in attendance. Whereas only 18% of the schools have both CS and IT gateway courses available, 30% of the students attend those schools. And 47% of the students attend schools with only CS gateway courses, with only 4% attending 5% of the schools with only IT gateway courses.

| | % Schools with Availability | % Students in Attendance |
|---|---|---|
| **Both CS and IT gateway** | 18% | 30% |
| **Only CS gateway** | 35% | 47% |
| **Only IT Gateway** | 5% | 4% |

***Table 16.*** Schools with availability of CS and IT Gateway Courses Compared to Students in Attendance

## RQ 5. By State Attendance at Schools with Gateway & Cybersecurity Courses

Figure 13 shows the distribution of the gateway courses by state and Figure 14 shows the distribution of cybersecurity courses by state. Figure 15 compares the student population percentage in each state attending a school with gateway computing, non- gateway computing, no computing, and cybersecurity courses. For example, Arkansas has 46% of schools with gateway computing and these 46% serve 72% of the Arkansas 9-12 student body. 8% of Arkansas 9-12 schools have cybersecurity and these 8% enroll 15% of the Arkansas student body.

Figure 13 shows that 54% of Florida schools have gateway computing. These 54% serve 70% of the Florida student body. 11% of Florida schools have cybersecurity and they enroll 16% of the Florida student body.

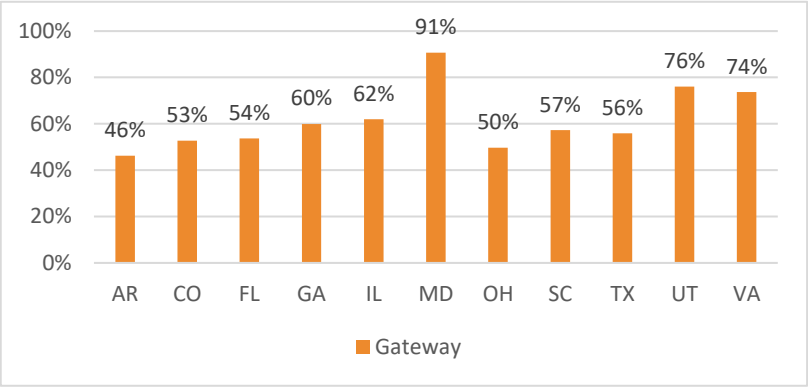



***Figure 13.*** SEQ Figure * ARABIC 13. Distribution of Gateway Courses by State

In contrast, 50% of Ohio schools have gateway computing, but these 50% only serve 70% of the high school student body in Ohio. More Ohio schools have gateway computing compared to Arkansas, 50% and 46% respectively. But more Arkansas students attend a school with gateway computing than do Ohio students, 72% vs. 70% respectively.

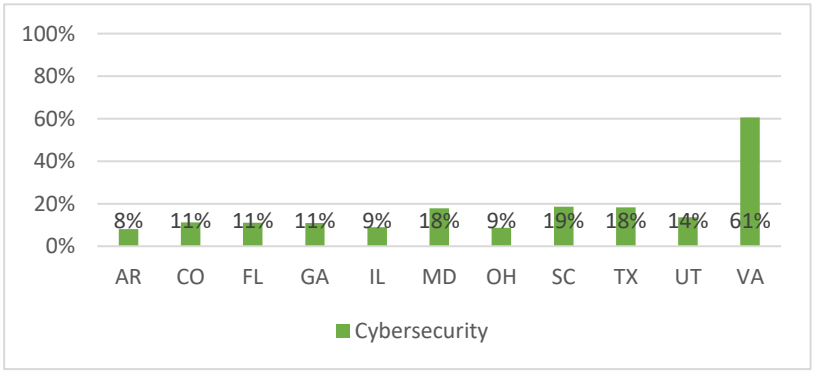



***Figure 14.*** SEQ Figure * ARABIC 14. Distribution of Cybersecurity Courses

Similar differences are worth observing in cybersecurity. For example, 11% of schools in Colorado, Florida and Georgia have cybersecurity. However, the percent of the student body attending these schools differs; 24% in Colorado, 14% in Georgia, and 19% in Illinois.

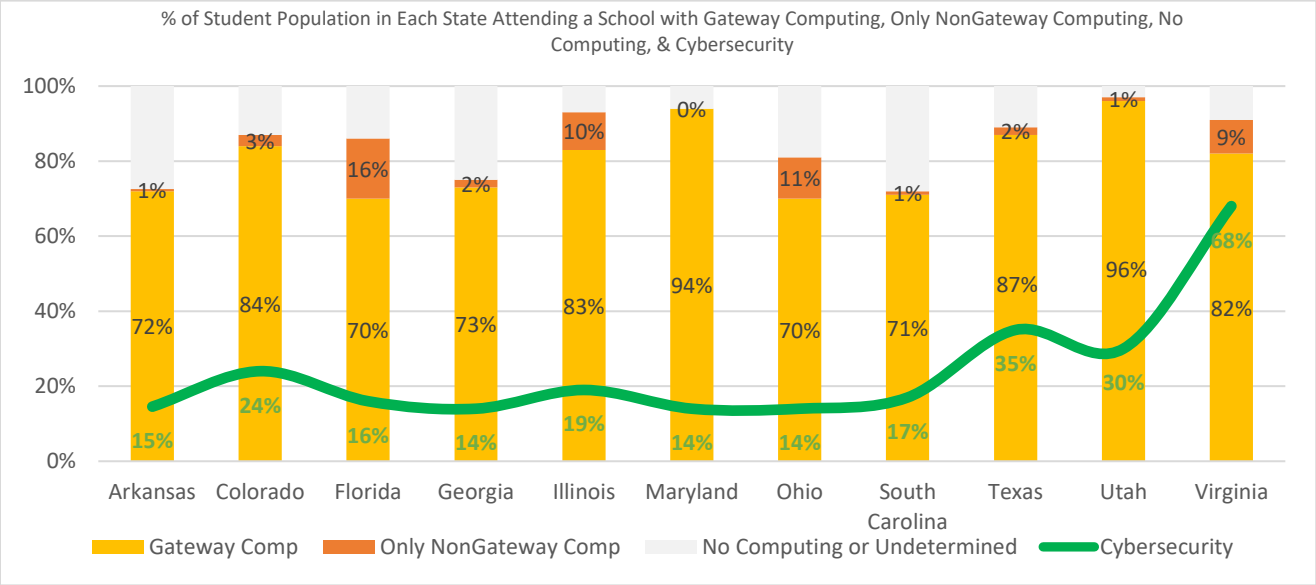



***Figure 15.*** Student Population Percentage Attending a School with Computing and Cybersecurity Offered by State

## RQ 6. Attendance by Race/Ethnicity

The study investigated attendance by race/ethnicity of students. In these states, the distribution of students by race was 49.5% underrepresented minorities (URM), 42.7% White, 4.4% Asian, 3.4% multi-racial as shown in Figure 16. URM is a category representing several races/ethnicities and because of this grouping they are the largest percentage of students overall.

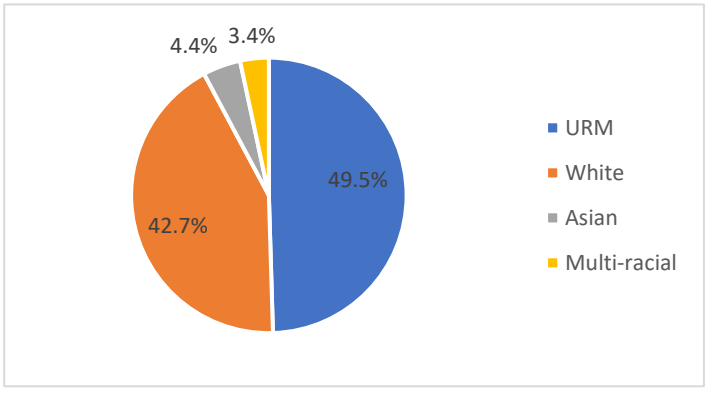
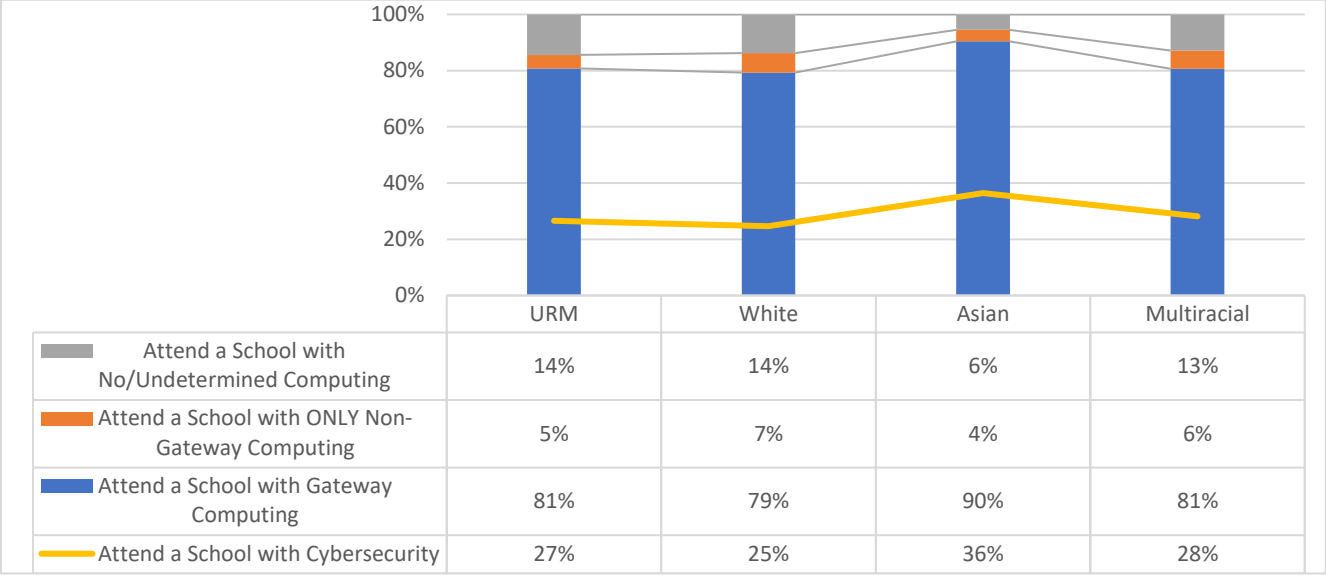



***Figure 16.*** SEQ Figure * ARABIC 16. Distribution of Students by Race/Ethnicity

Figure 17 shows that 81% of all students in the study attend a school with gateway computing. URM and multi-racial students follow the overall average of 81% attending a school with gateway computing. 79% of White students attend a school with gateway computing, and 90% of Asian students do. So, while Asian students are a small percentage of the population of students (4.4% of nearly 5 million students), a larger percentage of the Asian students attend a school with gateway computing.

26% of all students in the study attend a school with cybersecurity. Regarding cybersecurity, 27% of URM students attend a school with cybersecurity, 28% of multi-racial students do, 25% of White students do, and 36% of Asian students attend a school with cybersecurity. As can be seen in the chart below, the students who attend schools with only non-gateway computing tend to be White (7%), as compared to 6% multi-racial, 5% URM, and 4% Asian.




| | URM | White | Asian | Multiracial |
|---|---|---|---|---|
| Attend a School with No/Undetermined Computing | 14% | 14% | 6% | 13% |
| Attend a School with ONLY Non-Gateway Computing | 5% | 7% | 4% | 6% |
| Attend a School with Gateway Computing | 81% | 79% | 90% | 81% |
| Attend a School with Cybersecurity | 27% | 25% | 36% | 28% |

***Figure 17.*** Attendance by Race/Ethnicity

The trend shown in the graph above continues when looking at individual states with the exception of Virginia. Across all states, except Virginia, a larger percentage of the Asian student population attend a school with gateway computing as shown in Table 16 (green shading denotes highest % attending a school with gateway computing by race for each state).

| State | Race/Ethnicity | | | |
|---|---|---|---|---|
| | URM | White | Asian | Multi-racial |
| AR | 69% | 73% | **81%** | 74% |
| CO | 78% | 88% | **91%** | 88% |
| FL | 71% | 67% | **78%** | 66% |
| GA | 75% | 68% | **91%** | 72% |
| IL | 80% | 85% | **93%** | 88% |
| MD | 90% | 97% | **98%** | 97% |
| OH | 59% | 84% | **92%** | 80% |
| SC | 70% | 71% | **80%** | 71% |
| TX | 87% | 87% | **96%** | 92% |
| UT | 97% | 96% | **98%** | 97% |
| VA | **86%** | 78% | 80% | 85% |

***Table 17.*** Percent of Student Population by Race/Ethnicity Attending School with Gateway Computing

Attendance at a school with cybersecurity by race within each state varies more as shown in Table 17. However, in 7 of 11 states, the percent of Asian students attending a school with cybersecurity is higher than other races, which is fairly consistent.

| State | Race/Ethnicity | | | |
|---|---|---|---|---|
| | URM | White | Asian | Multi-racial |
| AR | 10% | 17% | **19%** | 16% |
| CO | 23% | 23% | 24% | **30%** |
| FL | 15% | **17%** | 16% | 15% |
| GA | 13% | 15% | **20%** | 15% |
| IL | 17% | 19% | **36%** | 23% |
| MD | **15%** | **15%** | 8% | 12% |
| OH | 12% | 14% | **22%** | 14% |
| SC | **17%** | **17%** | **17%** | 14% |
| TX | 35% | 34% | **45%** | 40% |
| UT | **30%** | 25% | 27% | 28% |
| VA | 70% | 65% | **80%** | 72% |

***Table 18.*** Percent of Student Population by Race/Ethnicity Attending a School with Cybersecurity

It should be noted here that these data report the percentage of students by race who attend a school with either cybersecurity, computing, or non-computing classes; not whether those classes are offered, and if so, whether they enroll in them.

## RQ 7. How many students have access to gateway and cybersecurity courses?

In the section above, we reported that 81% of students attend a school with gateway computing and 26% attend a school with cybersecurity. While the attendance figures initially look promising, attendance does not equal access. Access is a function of the number of courses available and the number of times in a school day/year the courses are offered.

So, what is a reasonable estimate for access? Access is a function of:

- % of schools with gateway or cybersecurity courses
- # of students served in those schools per year[9], and
- # of courses available to those students, and the number of students that could be served with those courses.

We modeled a low and high estimate. The low estimate is the odds of being in a school with gateway computing or a cybersecurity course and getting into the course assuming it is offered one time to 25 students. The high estimate is the odds of being in a school with gateway computing or cybersecurity course and getting into the courses assuming it is offered 3 times to 25 students. We found that:

- 24.4%-73.3% of the students have access to gateway computing, or 278,175 to 812,313 students.
- 3.7%-11.0% of the students access to cybersecurity, or 44,975 to 134,925 students.

## RQ8. Access by State

Access varies by state because availability varies by state as shown in Tables 18 and 19. Access to gateway computing in Arkansas is estimated between 33.5% to 72.0% of all Arkansas students. While only 46% of Arkansas schools have gateway computing, these schools serve 72% of the high school population in Arkansas with 345 courses. If each course was offered 1 time to 25 students, 8,625 students could enroll, which is 33.5% of ¼ of the Arkansas student body of 103,017.

Access to gateway computing in Texas is estimated between 28.8% to 86.5%. 56% of Texas schools have gateway computing. 87% of the high school student population attends these schools. Texas schools have 4,244 gateway courses. These factors together mean that somewhere between 106,100 and 318,300 of the 368,057 Texas high school students have access in any given year. In contrast, Maryland had the highest percentage of schools with gateway computing (91%) offering fewer gateway courses per student with 94% of the student population attending these schools. But fewer large schools (15% in Maryland). Given all factors, the chances that a Maryland high school student has access to gateway computing in Maryland is 21.4% to 64.1%.

[9] We used ¼ of total students assuming the course would be offered every year.

Access to cybersecurity courses is low across all states except Virginia at 13.6% to 40.9%. The low estimate for Arkansas is 5.6% and for all states it is under 4%. Our feeling is that the low estimate is more realistic for cybersecurity; it is doubtful that many of these courses are taught more than 1 time a day. Virginia with 61% of schools offering 497 cybersecurity courses, means that an estimated 12,425 to 37,275 students in any given year have access to cybersecurity in Virginia.

| State | % of Students w/ Access to Gateway Courses | | % of Students w/ Access to Cybersecurity Courses | |
|---|---|---|---|---|
| | Low | High | Low | High |
| **AR** | 33.5% | 72.0% | 5.6% | 15.0% |
| **CO** | 21.5% | 64.6% | 2.6% | 7.7% |
| **FL** | 9.3% | 28.0% | 2.1% | 6.4% |
| **GA** | 14.2% | 42.5% | 1.5% | 4.5% |
| **IL** | 23.0% | 69.0% | 2.1% | 6.4% |
| **MD** | 21.4% | 64.1% | 2.4% | 7.3% |
| **OH** | 24.8% | 70.0% | 2.9% | 8.7% |
| **SC** | 30.2% | 71.0% | 3.7% | 11.1% |
| **TX** | 28.8% | 86.5% | 3.7% | 11.2% |
| **UT** | 25.8% | 77.3% | 2.6% | 7.7% |
| **VA** | 24.4% | 73.3% | 13.6% | 40.9% |

***Table 19.*** Estimate Ranges of Access to Gateway Computing and Cybersecurity Courses by State

| State | # of Students with Access to Gateway Courses | | # of Students with Access to Cybersecurity Courses | |
|---|---|---|---|---|
| **AR** | 8625 | 25875 | 1450 | 4350 |
| **CO** | 12125 | 36375 | 1450 | 4350 |
| **FL** | 16675 | 50025 | 3825 | 11475 |
| **GA** | 17800 | 53400 | 1875 | 5625 |
| **IL** | 29800 | 89400 | 2775 | 8325 |
| **MD** | 13900 | 41700 | 1575 | 4725 |
| **OH** | 25375 | 76125 | 2950 | 8850 |
| **SC** | 15925 | 47775 | 1950 | 5850 |
| **TX** | 106100 | 318300 | 13750 | 41250 |
| **UT** | 9550 | 28650 | 950 | 2850 |
| **VA** | 22300 | 66900 | 12425 | 37275 |

***Table 20.*** Range of Students who have Access to Gateway Computing and Cybersecurity Courses by State

## RQ9. Access by Race/Ethnicity

As reported earlier, 90% of the 218,897 Asian students in the study sample attend a school with gateway and cybersecurity courses, in comparison to 81% of the 2,440,799 URM students, and 2,103,299 White students. The same largely holds true for cybersecurity courses where 36% of the Asian students attend a school with cybersecurity compared to 27% of URM students and 25% of White students. The effect is that access percentages increase/decrease by race/ethnicity as shown in Table 21.

| | Gateway Computing | | Cybersecurity | |
|---|---|---|---|---|
| | **Low** | **High** | **Low** | **High** |
| **All** | 24.4% | 73.3% | 3.7% | 11.0% |
| **URM** | 24.4% | 73.3% | 3.8% | 11.4% |
| **White** | 23.8% | 71.5% | 3.6% | 10.9% |
| **Asian** | 27.1% | 81.4% | 4.7% | 14.0% |
| **Multiracial** | 24.4% | 73.3% | 3.9% | 11.8% |

***Table 21.*** Gateway Computing and Cybersecurity Course Access by Race/Ethnicity

Between 27.1% and 81.4% of Asian students have access to a gateway computing course compared to 24.4% - 73.3% of all students. And between 4.7% and 14.0% of Asian students have access to a cybersecurity course compared to 3.7% - 11.0% of all students.

# Designation

CyberSupply assumed that a Cybersecurity Program of Excellence would recognize schools with cybersecurity "programs." One way to define a program is to look at pathways that exist within states.

## RQ 10. Pathways in States

Generically, a college-to-career pathway is a career-themed and college preparatory program available at a high school or CTE center. Career pathways in secondary education are often linked to the Carl D. Perkins Vocational and Technical Education Act. This act was first authorized by the federal government in 1984 and has been reauthorized in 1990 (Perkins II), 1998 (Perkins III), 2006 (Perkins IV), and 2018 (Perkins V). The act aims to increase the quality of career and technical education (CTE) within the United States in order to help the economy.

According to Advance CTE (a national non-profit that represents State CTE Directors and state leaders of Career Technical Education), there are 16 Career Clusters in the National Career Clusters Framework, representing 79 Career Pathways. Some states have added additional clusters. For example, Florida has added Energy for a total of 17 career clusters.

1. Agriculture, Food & Natural Resources
2. Architecture & Construction
3. Arts, A/V Technology & Communications
4. Business Management & Administration
5. Education & Training
6. Finance
7. Government & Public Administration
8. Health Science
9. Hospitality & Tourism
10. Human Services
11. Information Technology
12. Law, Public Safety, Corrections & Security
13. Manufacturing
14. Marketing
15. Science, Technology, Engineering & Mathematics
16. Transportation, Distribution & Logistics

As states have integrated computing into their schools, it is found in either the Information Technology (IT) career cluster or the STEM career cluster. The IT cluster has four pathways:

1. Network Systems Pathway
2. Information Support & Service Pathway
3. Web & Digital Communications Pathway
4. Programming & Software Development Pathway

The STEM Career Cluster has two pathways:

1. Engineering & Technology Pathway
2. Science & Mathematics Pathway

CyberSupply investigated whether cybersecurity is integrated into these pathways in the 11 states, and if so, where (shown by the "x" in Table 22) and how deep (shown by the blue-red shading). Not surprisingly, the implementation of cybersecurity into pathways across states varies. As shown in Table 21, cybersecurity is found in general IT, network systems, and programming and software development, which are all in the IT career cluster. In addition, in Texas and Virginia, cybersecurity is found in the engineering & technology pathway in the STEM career cluster.

Cybersecurity is sometimes a dedicated **program** within a pathway, which means that there are at least 2 cybersecurity courses in the CTE pathway. The states with **cybersecurity programs** are denoted by the cells highlighted blue in Table 21. Eight of the 11 states have 10 cybersecurity programs; Virginia has three. The three states that do not have cybersecurity programs are Illinois, Maryland, and South Carolina denoted by the cells highlighted in red in the table below. Of the 10 cybersecurity programs, 4 are in the general IT pathway, 2 in the network systems pathway, 2 in the programming and software development pathway, and 2 in engineering & technology.

| | Information Technology Career Cluster | | | | | STEM | |
|---|---|---|---|---|---|---|---|
| | General IT | Network Systems | IT Support & Service | Web & Digital Communication | Programming & Software Development | Engineering & Technology | Science & Mathematics |
| AR | | | | | x | | |
| CO | | x | | | | | |
| | | x | | | | | |
| FL | x | | | | | | |
| | x | | | | | | |
| | x | | | | | | |
| GA | x | | | | | | |
| IL | | x | | | | | |
| MD | | x | | | x | | |
| OH | x | | | | | | |
| SC | | x | | | x | | |
| TX | | | | | | x | |
| UT | x | | | | | | |
| VA | | x | | | x | x | |

***Table 22.*** Pathways with Cybersecurity by State

In addition to the three cybersecurity programs in Virginia, cybersecurity courses are also found in the following career clusters: Business Management & Administration, Agriculture, Food & Natural Resources, and Manufacturing.

If the designation program decided to use CTE pathways as the criteria for recognition, then 3 of the 11 states in our study would not have any eligible schools. If the 11 states are representative of the U.S., then 14 states would not have any eligible schools.

However, the designation program could decide to recognize schools using criteria other than state designated CTE programs.

## RQ 11. Recommended Model for Designation

How might courses constitute pathways for possible designation? Cybersecurity is a discipline that is grounded in CS and IT. As Figure 18 shows, 37% of the schools/CTE centers have no computing; 5% have only non-gateway computing; 35% have ONLY CS gateway courses; and 5% have only IT gateway courses. This leaves 18% (1,096) of all schools and CTE centers in the study with both CS and IT gateway courses as shown in Table 23.

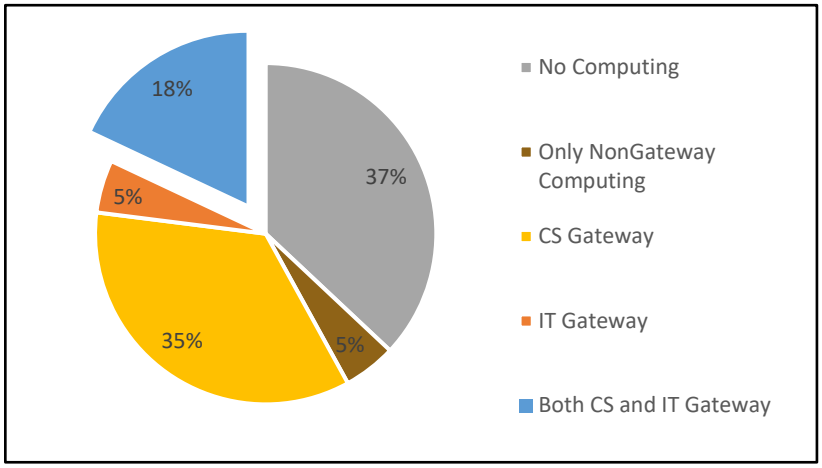



***Figure 18.*** SEQ Figure * ARABIC 18. Distribution of CS, IT, Non Gateway Courses

| | Both CS and IT Gateway | CS Gateway | IT Gateway | Non-Gateway | No Computing | Total |
|---|---|---|---|---|---|---|
| **With Cybersecurity** | 508 | 317 | 76 | 48 | 1 | 950 |
| **Without Cybersecurity** | 588 | 1851 | 208 | 481 | 2029 | 5157 |
| **Total** | 1096 | 2168 | 284 | 529 | 2030 | 6107 |

***Table 23.*** Number of Schools with CS, IT, Non Gateway and No Computing Courses

Of the 1,096 schools and CTE centers with both CS and IT gateway courses, 8% (508) also have cybersecurity courses. Table 24 shows that 220 of the 508 schools/CTE centers have a single cybersecurity course, and 288 have ≥2 cybersecurity courses, which is pertinent because at least two courses are required for a secondary CTE pathway. The net effect is that 4.7% of the schools in the sample have both CS and IT gateway courses and ≥2 cybersecurity courses to comprise a cybersecurity pathway.

| | Both CS and IT Gateway |
|---|---|
| **With ≥2 Cybersecurity** | 288<br>(4.7%) |
| **With 1 Cybersecurity** | 220<br>(3.6%) |

***Table 24.*** Number of Cybersecurity Courses in CS and IT Gateways

Assuming the sample is representative of the country, there are ~657 public high schools in the U.S. that currently have sufficient CS, IT and a minimum of 2 cybersecurity courses to make a cybersecurity pathway at this time. As we know, this does not mean that these schools/CTE centers *actually have* a cybersecurity pathway; Illinois, Maryland, and South Carolina do not have Cybersecurity programs. And for the 8 states that have cybersecurity CTE programs, it does not mean that the courses analyzed in this study comprise the

existing pathway or could be sequenced in these schools in a way that comprises a pathway. Rather the numbers simply report the number of schools that appear to have enough courses that could make a pathway if the school wanted to do so.

This said, there are reasons why the ~657 estimate could be inflated.

1. These courses may not actually be offered. Computing courses are usually electives, and cybersecurity classes are always electives. Electives are offered based on student interest and demand.
2. A limiting factor is the number of teachers, and availability of labs. Computing and cybersecurity courses are often dependent upon a qualified teacher. If no teacher can be hired or replaced, then the course(s) cannot be offered even if student demand is sufficient for the class to be offered.
3. State requirements for pathways may not align to national designation requirements.
4. The quality of program has not been factored in; if the programs are to meet a minimum quality standard, then the number will surely decline.

## RQ 12. A Wider Net

While it is our opinion that both CS and IT, and 2 or more cybersecurity courses *should* be required for designation consideration, we also looked at how many schools would be potentially eligible if other criteria were used. Level 4 is the level presented above that nets 4.7% of schools, or an estimated 657 nationwide. Table 25 provides the net number and percent of schools for the following four levels:

Level 4 – CS **and** IT gateway and ≥2 cybersecurity courses
Level 3– CS **or** IT gateway and ≥2 cybersecurity courses
Level 2 – CS **and** IT gateway and 1 cybersecurity course
Level 1– CS **or** IT gateway and 1 cybersecurity course

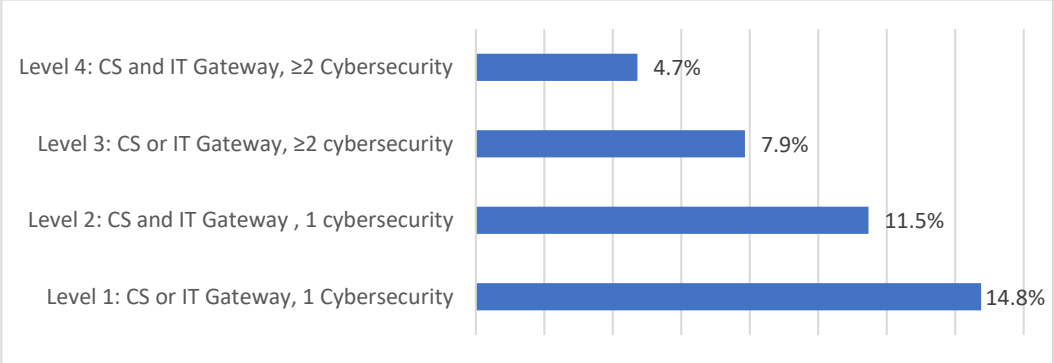
| | Both CS and IT Gateway | CS Gateway | IT Gateway | SubTotal | Non-Gateway | No Computing | Total |
|---|---|---|---|---|---|---|---|
| **With ≥2 Cybersecurity** | 288 (4.7%) | 160 (2.6%) | 32 (.5%) | 480 (7.9%) | 32 | 1 | 513 |
| **With 1 Cybersecurity** | 220 (3.6%) | 157 (2.6%) | 44 (.7%) | 421 (6.9%) | 16 | 0 | 437 |
| **Total** | 508 (8.3%) | 317 (5.2%) | 76 (1.2%) | 901 (14.8%) | 48 | 1 | 950 |

***Table 25.*** Net Distribution of Schools by CS and IT Gateways with Cybersecurity Courses for Four Levels

Table 26 below summarizes the increase in the number schools potentially eligible for the designation based on the inclusion criteria. For level 4 (CS **and** IT gateway courses, and two cybersecurity courses), the estimate is there are ~657 schools potentially eligible for designation, 4.7% of U.S. regular public high schools[10]. The level 3 number climbs to ~1099 schools (7.9%), ~1600 schools for level 2 (11.5%), and ~2059 schools for level 1 (14.8%).

| Inclusion Criteria | % | Cumulative % | Estimated # of Schools Potentially Eligible |
|---|---|---|---|
| Level 4: CS **and** IT Gateway, ≥2 Cybersecurity | 4.7% | 4.7% | 657 |
| Level 3: CS **or** IT Gateway and ≥2 cybersecurity | 3.1% | 7.9% | 1099 |
| Level 2: CS **and** IT Gateway and 1 or more cybersecurity | 3.6% | 11.5% | 1600 |
| Level 1: CS **or** IT Gateway and 1 or more Cybersecurity | 3.3% | 14.8% | 2059 |

***Table 26.*** Number of Schools Potentially Eligble for Designation




## Eligible Schools at the Levels by Title I Status

Using the same 4 levels of criteria for designation, level 4 would net 156 Title I schools potentially eligible, 4.2% of the population of Title I schools in the sample as shown in Table 27. In comparison, 119 of the non-Title I schools would be eligible for the designation, or 5.5%.

| | Level 4<br>CS and IT Gateway,<br>≥2 Cybersecurity | Level 3<br>CS or IT Gateway,<br>≥2 Cybersecurity | Level 2<br>CS and IT Gateway,<br>1 Cybersecurity | Level 1<br>CS or IT Gateway,<br>Cybersecurity |
|---|---|---|---|---|
| **Title I** | 156<br>(4.2%) | 63<br>(1.7%) | 112<br>(3.0%) | 74<br>(2.0%) |
| **Not Title I** | 119<br>(5.5%) | 115<br>(5.3%) | 95<br>(4.4%) | 108<br>(5.0%) |

***Table 27.*** Number of Schools Potentially Eligble for Designation by Title 1 Status

[10] There are ~13,000 private high schools in the U.S. Data for private schools are not curated in NCES and therefore, private schools were not included in this study. If they are included in the designation program, these numbers could as much as double.

Figure 19 below shows the cumulative percent. When all four levels are used for designation, the number increases to 10.8% of all Title I schools. But the number of non-Title I schools increases to 20.1%. 70% of schools in the U.S. are Title I, so if the goal is large growth, then more inclusive criteria could cast a wider net. In order to cast a net wide enough to include more Title I schools, the result is that such a policy would provide more advantage to non-Title I schools.

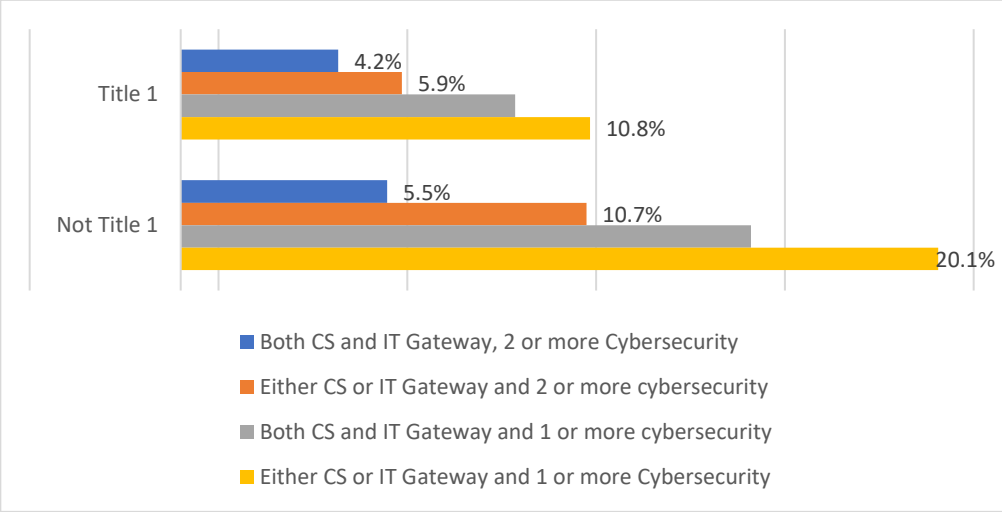



***Figure 19.*** Percent of Schools by Title 1 Status across the Four Levels

## Eligible Schools at the Levels by School Size

Differences continue by school size as shown in Table 28. Level 4 criteria would net 40 schools with <600 students (2.3%) as potentially eligible, many of which are rural. As size increases so do the number of schools eligible at every level. As Figure 20 shows, using all four levels in the end nets 7.7% of the very small schools, but 34.4% of the large schools.

| | Level 4<br>CS and IT Gateway, ≥2 Cybersecurity | Level 3<br>CS or IT Gateway, ≥2 Cybersecurity | Level 2<br>CS and IT Gateway, 1 Cybersecurity | Level 1<br>CS or IT Gateway, Cybersecurity |
|---|---|---|---|---|
| <600 | 40<br>(2.3%) | 20<br>(1.1%) | 37<br>(2.1%) | 37<br>(2.1%) |
| 600-1200 | 50<br>(5.5%) | 24<br>(2.6%) | 30<br>(3.3%) | 35<br>(3.8%) |
| 1201-2000 | 82<br>(8.2%) | 47<br>(4.7%) | 58<br>(5.8%) | 48<br>(4.8%) |
| >2000 | 79<br>(10.2%) | 72<br>(9.3%) | 74<br>(9.5%) | 43<br>(5.5%) |

***Table 28.*** Distribution of Schools by Size across the Four Levels

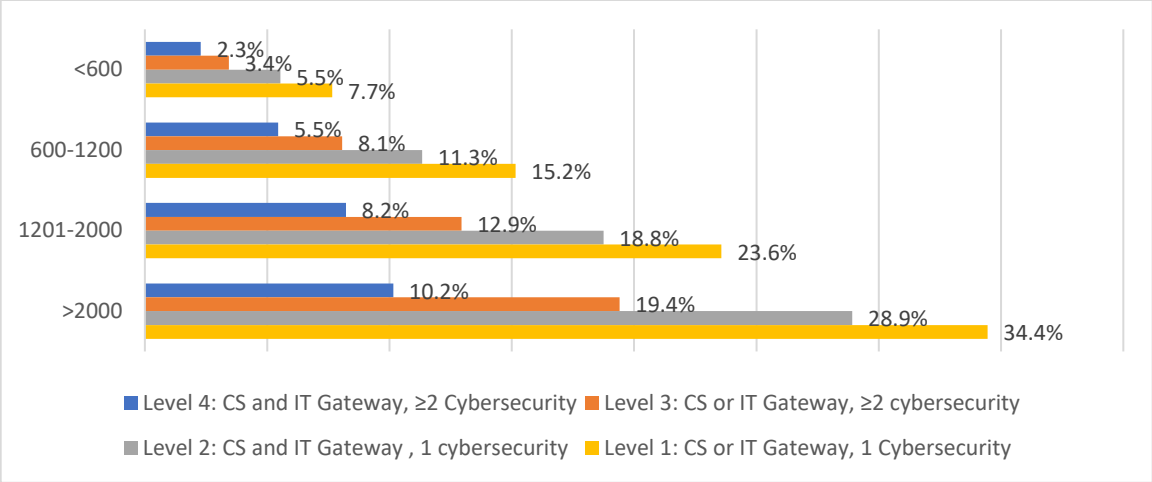



***Figure 20.*** Percent of Schools compared across the Four Levels by School Size

## Eligible Schools at Levels by State

At level 4, Arkansas would only have 1 school (less than 1% of its population of schools), while Texas would have 129 schools, which is 7.8% of the school population in Texas. And Virginia would have 58 schools, which represents 17.7% of all schools in Virginia. As the criteria relax, the numbers go up across all states. Going all the way to level 1 would make a cumulative total of 25 Arkansas schools potentially eligible, or 7.7% of all Arkansas schools. So, 7.8% of Texas schools would be potentially eligible if only level 4 criteria were used, but to get an equivalent percent of schools in Arkansas, all four levels are needed. Yet if all four levels are used, 18.1% of Texas schools are eligible and 51.7% of Virginia schools are. The most restrictive criteria (level 4 only) will result in very few eligible schools in some states. In an effort to be more inclusive, other states will have an advantage for more designations and associated benefits. Of course, the more schools in the program, the more it will cost to operate the program as well, which is another important consideration.

| | **Level 4 CS and IT Gateway, ≥2 Cybersecurity** | **Level 3 CS or IT Gateway, ≥2 Cybersecurity** | **Level 2 CS and IT Gateway, 1 Cybersecurity** | **Level 1 CS or IT Gateway, Cybersecurity** |
|---|---|---|---|---|
| **AR** | 1 (0.3%) | 17 (5.2%) | 4 (1.2%) | 3 (0.9%) |
| **CO** | 3 (0.8%) | 9 (2.3%) | 6 (1.6%) | 24 (6.2%) |
| **FL** | 24 (4.2%) | 21 (3.7%) | 5 (0.9%) | 7 (1.2%) |
| **GA** | 16 (3.5%) | 10 (2.2%) | 17 (3.8%) | 6 (1.3%) |
| **IL** | 15 (2.0%) | 3 (0.4%) | 15 (2.0%) | 33 (4.3%) |
| **MD** | 17 (7.6%) | 4 (1.8%) | 3 (1.3%) | 16 (7.1%) |
| **OH** | 8 (0.9%) | 17 (1.9%) | 20 (2.2%) | 27 (3.0%) |
| **SC** | 14 (4.9%) | 6 (2.1%) | 14 (4.9%) | 18 (6.3%) |
| **TX** | 129 (7.8%) | 36 (2.2%) | 103 (6.2%) | 33 (2.0%) |
| **UT** | 3 (1.5%) | 4 (2.0%) | 5 (2.4%) | 16 (7.8%) |
| **VA** | 58 (17.7%) | 65 (19.9%) | 28 (8.6%) | 18 (5.5%) |

***Table 29.*** Distribution of Schools by State Across the Four Levels

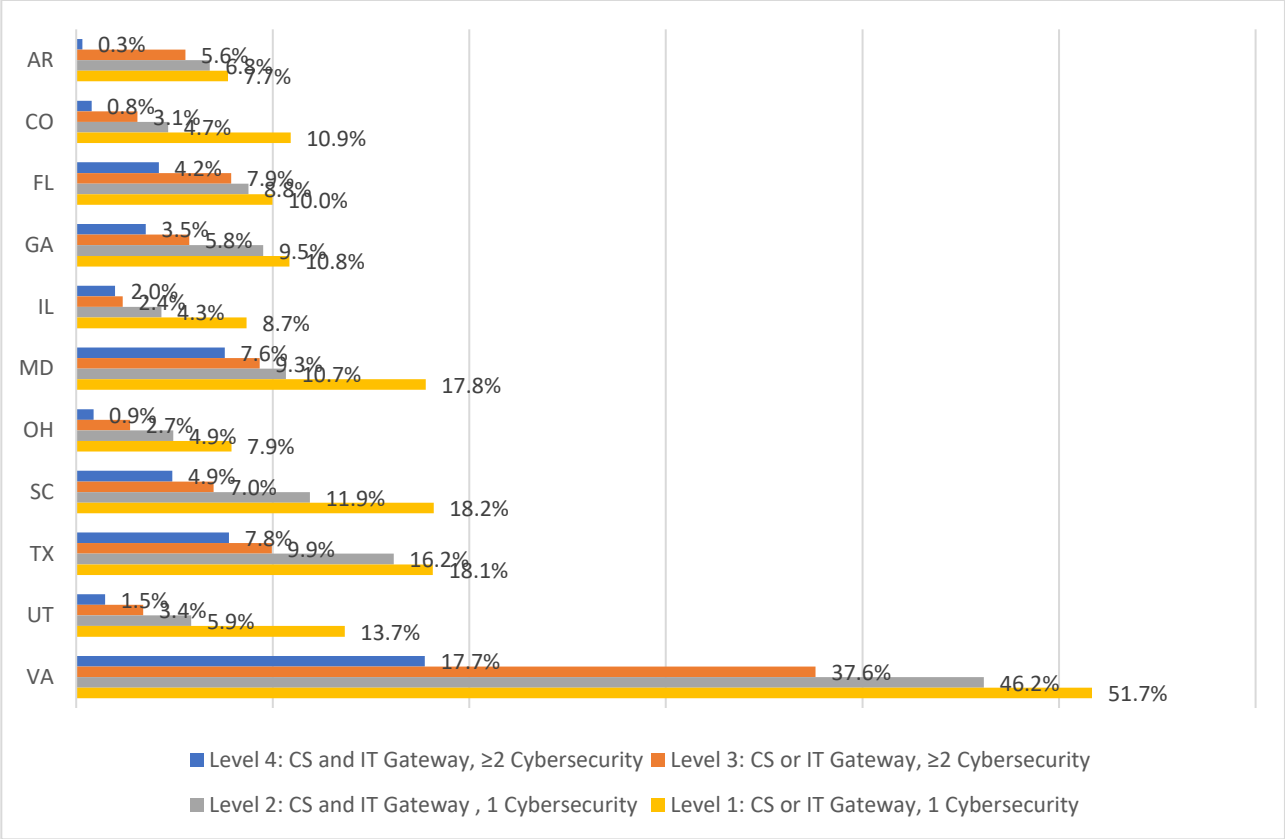



***Figure 21.*** Percent of Schools compared across the Four Levels by State

Stated earlier in the report was the finding that 288 schools in the 11 states would be potentially eligible for designation using the most restrictive criteria (CS and IT Gateway and 2 Cybersecurity) and 901 would be eligible given the least restrictive criteria as shown in Table 30.

| | Both CS and IT Gateway | CS Gateway | IT Gateway | Total |
|---|---|---|---|---|
| **With 1 Cybersecurity** | 220 | 157 | 44 | 421 |
| **With ≥2 Cybersecurity** | 288 | 160 | 32 | 480 |
| **Total** | 508 | 317 | 76 | 901 |

***Table 30.*** Number of Cybersecurity Courses in CS and IT Gateways

These numbers assume that the criteria that matter are only the number and type of courses, and not the pathways and programs within these states. If the designation program would decide to **only** designate pathways and programs within recognized states, that also meet the least restrictive criteria, then the number of potentially eligible programs drops as shown in Table 31. The states with cybersecurity programs are denoted by the blue cells and those do not are shaded red.

| | | Information Technology Career Cluster | | | | | STEM | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | General IT | Network Systems | IT Support & Service | Web & Digital Communication | Programming & Software Development | Engineering & Technology | Science & Mathematics | |
| AR | 25 | | | | | 10 | | | 10 |
| CO | 42 | | 30 | | | | | | 42 |
| | | | 12 | | | | | | |
| FL | 57 | 21 | | | | | | | 31 |
| | | 5 | | | | | | | |
| | | 5 | | | | | | | |
| GA | 49 | 3 | | | | | | | 3 |
| IL | 66 | | 0 | | | | | | 0 |
| MD | 40 | | 7 | | | 15 | | | 22 |
| OH | 72 | 6 | | | | | | | 6 |
| SC | 52 | | 8 | | | 37 | | | 45 |
| TX | 301 | | | | | | 164 | | 164 |
| UT | 28 | 7 | | | | | | | 7 |
| VA | 169 | | 36 | | | 73 | 29 | | 138 |
| Total | | | | | | | | | 456 |

***Table 31.*** Number of Eligible Programs by State and Pathway Type

If a minimum of 2 cybersecurity courses are required (blue-shaded cells), the number totals 282.

| | | | |
|---|---|---|---|
| **AR** | 10 | **OH** | 0 |
| **CO** | 12 | **SC** | 0 |
| **FL** | 21 | **TX** | 164 |
| **GA** | 3 | **UT** | 7 |
| **IL** | 0 | **VA** | 65 |
| **MD** | 0 | **OH** | 0 |
| **Total 282** | | | |

***Table 32.*** Number of Schools with Two Cybersecurity Courses in IT or STEM Pathways by State

# Conclusions

This study was undertaken with the purposes of a) determining the extent to which cybersecurity is embedded in U.S. high schools, b) considering how U.S. schools can leverage their computer science and information technology gateway courses to create cybersecurity pathways, and c) gauging the number of schools that might be ready for a designation as a "Program/School of Excellence".

## Study Conclusions

### Conclusion 1: The cybersecurity landscape is barren with pockets of growth.

The current landscape of cybersecurity education at the high school level is fairly barren with some pockets of growth. To summarize some of the key findings that describe the current landscape of cybersecurity education:

- 16% of U.S. regular public high schools have cybersecurity and 26% of 9-12 students attend these schools. However, due to other limiting factors such as availability of qualified teachers, computer labs, the crowded curriculum, and sequencing and scheduling limits, access to cybersecurity education is estimated at **3.7%** of the U.S. high school population, ~566,000 students have access to a cybersecurity course over their high school career.
- If students have access to a cybersecurity course it is most likely Cybersecurity I and it is part of an IT or STEM pathway.
- Title I status affects access to cybersecurity regardless of school size and locale.
- School size impacts student access to cybersecurity.
- Pockets of growth tend to be larger, non-Title I schools. Generally speaking, the most disadvantaged students are those in Title I, small schools. These high schools are typically disadvantaged by the shortage of certified teachers with subject matter expertise, limited ability to offer diverse elective courses, and the high cost per pupil to offer electives requiring expensive technology.
- The highest percentage of students by race to attend a school with cybersecurity is Asian students at 36%, even though they represent a small portion of the student body.
- While Title I status, school size, and race/ethnicity are access factors, we found notable differences by states, which is undoubtedly a function of state policy, population, and economy. For example:
    - Florida: 71% of the 9-12 schools that are medium-large schools, and 79% are Title I. Florida is densely populated but sparse on cybersecurity courses resulting in an estimated 2.1% of the student population with access to cybersecurity.
    - Colorado: 35% of the 9-12 schools are medium-large, and 13% are Title I. With a less dense population and more cybersecurity course per student, 2.6% of Colorado students have access to cybersecurity.
    - Arkansas: 14% of the 9-12 schools are medium-large, and 87% are Title I. Arkansas is sparsely populated and dense on cybersecurity courses, which gives 5.6% of Arkansas high school students access to cybersecurity.

## Conclusion 2: Leveraging computer science and IT gateway courses can help grow cybersecurity.

Taking the landscape analogy further, there are consistent elements that have been shown to nurture the planting and growth of cybersecurity. We have termed these gateway-to-cybersecurity courses in both computer science and information technology. Expanding our lens to include these courses helps to see where and how future growth of cybersecurity might emerge in the landscape. And we see the healthiest manifestation of growth to be cybersecurity pathways that include a CS and IT foundation. However, the same environmental features that appear to inhibit availability and access to cybersecurity courses, i.e., Title I status and school size also limit the availability of gateway-to-cybersecurity courses. To summarize some of the key findings that describe the current landscape of gateway-to-cybersecurity education:

- 58% of U.S. regular public high schools have gateway computing courses and 81% of 9-12 students attend these schools. However, due to other limiting factors such as availability of qualified teachers, computer labs, the crowded curriculum, and sequencing and scheduling limits, access to gateway computing is estimated between 24.4% to 73.3% of the U.S. high school population. The low estimate assumes each gateway course is offered 1 time per school year to 25 students and the high estimate assumes 3 times per year to 75 students. Using this estimate, between 930K to 2.8M students have access to a gateway-to-cybersecurity course over their high school career.
- If students have access to a gateway course it is most likely a computer science gateway course, which in some states falls into the cybersecurity pathway in IT/STEM. But not always.
- Title I status affects access to gateway-to-cybersecurity as does school size.
- Not only do Title I schools have fewer gateway courses compared to non-Title I schools (52% vs. 68% respectively), Title I schools have more NON-gateway courses than non-Title I schools (9% vs. 8% respectively).
- Larger schools have more gateway-to-cybersecurity courses. And smaller schools have more NON -gateway courses.
- Pockets of growth tend to be larger, city/suburban/town, non-Title I schools. But Title I and smaller schools have NON -gateway courses that could be repurposed to gateway.
- Again, the highest percentage of students by race to attend a school with gateway-to-cybersecurity is Asian students at 90%, even though they represent a small portion of the student body.
- While Title I status, school size, and race/ethnicity all affect access, we found notable differences by states, which is undoubtedly a function of state policy, population, and economy. For example:
    - Florida: 71% of the 9-12 schools that are medium-large schools, and 79% are Title I. Florida is densely populated but sparse on gateway-to-courses resulting in an estimated 9.3%-28.0% of the student population with access to gateway-to-cybersecurity courses. Of note, Florida has a lot of NON-gateway courses.
    - Colorado: 35% of the 9-12 schools are medium-large, and 13% are Title I. With a less dense population and more cybersecurity course per student, 21.5%-64.6% of Colorado students have access to gateway-to-cybersecurity.
    - Arkansas: 14% of the 9-12 schools are medium-large, and 87% are Title I. Arkansas a sparsely populated and dense on cybersecurity courses, which gives 33.5-72.0% of Arkansas high school students access to gateway-to-cybersecurity. AR has very few NON-gateway courses.

These factors are important to consider as we develop interventions and initiatives to spur cybersecurity across the U.S. educational landscape.

### Conclusion 3: Criteria have significant implications for how many and who gets designated

To summarize key findings, the less rigorous the criteria, the more schools could potentially apply. Below are the estimated number of schools we estimate would be eligible to apply:

- **657 if both CS and IT** gateway-to-cybersecurity courses and **2 cybersecurity courses** are required.
- **1099 if either CS or IT** gateway-to-cybersecurity courses and **2 cybersecurity courses** are required.
- **1600 if both CS and IT** gateway-to-cybersecurity courses and **1 cybersecurity course** are required.
- **2059 if either CS or IT** gateway-to-cybersecurity courses and **1 cybersecurity course** are required.

These estimates do not account for important quality factors such as rigor of the program, teacher qualifications, student enrollment, graduation and placement rates, etc.

If the Designation program decides to only recognize CTE pathways that exist in the state, we estimate there would be 27% of states that would not be eligible because they do not have a cybersecurity pathway in IT or STEM. The estimate of 657 above decreases to:

- **456** if the Designation program requires **both CS and IT** gateway-to-cybersecurity courses and **2 cybersecurity courses and a state level recognized CTE pathway.**

Finally, regardless of what criteria are used:

- Non-Title I schools will be advantaged. Less restrictive criteria net more Title I schools, which might be desirable. But less restrictive criteria net twice as many Non-Title I schools as Title I schools.
- Larger schools will be advantaged. Less restrictive criteria can increase the % of very small schools to 7.7%, but it increases the % of large schools to 34.4%.
- Virginia will be advantaged due to the number of schools with cybersecurity courses. Restrictive criteria would render practically all schools in some states ineligible (e.g., Arkansas has .3% of its schools with both CS and IT Gateway and 2 Cybersecurity courses). While more inclusive criteria can net more Arkansas schools (7.7%), Virginia accelerates the number of schools eligible by a factor of 6.5 schools for 1 school in Arkansas.

## Broader Conclusions

In reflecting on what we've learned through conducting this study, we offer the following broader conclusions on nurturing the educational cybersecurity ecosystem in the interest of building America's CyberSupply.

### Conclusion 4: The cybersecurity landscape reflects the status of K-12 education in the U.S. and the nature of the computing discipline.

K-12 education in the U.S. is localized with state-wide systemic disparities in access and availability to technology-rich, resource-intensive subject areas like cybersecurity. Of note is Virginia, which is an outlier in many of the findings presented above. The state leadership in Virginia has made a concerted effort to include cybersecurity in the CTE area, enriching the ecosystem to further support computer science and cybersecurity. In 2014, Governor Terry McAuliffe established Cyber Virginia and the Virginia Cybersecurity Commission. A

report entitled Virginia's 21st Century Career Pathway Cybersecurity was published in 2016 that set forth priorities, including developing cybersecurity pathways. And the Virginia Cyber Range was funded and developed to enhance cybersecurity education for students in the public high schools, colleges, and universities. No other states in the sample have experienced such a concerted effort. It is also interesting to note that Virginia has the lowest percentage of Title I schools and one of the highest percentages (80%) with gateway computing courses.

Various factors are impacting whether and how cybersecurity is being offered in a high school with larger schools more likely to have the resources needed to provide this course option. An often-identified issue is the lack of qualified teachers able to teach cybersecurity courses in 9-12. There are currently scant preservice teacher preparation programs for computer science and none for cybersecurity. For cybersecurity, teachers must pursue training offered via programs such as GenCyber teacher camps, NetAcademy, or through curriculum projects such as Teach Cyber, cyber.org, and PLTW. These training opportunities are usually limited in time (1-2 weeks) and scope (typically focused on a slice of cybersecurity). With such limited scope, teachers lack depth of knowledge to build robust cybersecurity courses and programs. Furthermore, if the teacher retires or transfers to another school, the cybersecurity integration leaves with them.

There are other issues that affect access. Access to cybersecurity courses is not only limited based on whether it is offered in a school, but also where cybersecurity is positioned in the school (i.e., business, computer science, information technology). The positioning can affect what, if any, prerequisites are required; and what other electives the course must compete with for student enrollment. There are significant variations in how cybersecurity is framed and delivered in high schools across the country. This is largely due to the fact that there are no agreed upon standards that articulate the foundational knowledge and skills needed for students with a passion and potential to envision a career in cybersecurity that helps teachers align their curriculum. In lieu of this, several high schools use varied industry-based certifications to structure the content of their courses to prepare students to take the certification exam. There is currently no evidence that this is educationally appropriate, scalable, leads to further interest in students to pursue cybersecurity, nor best prepares students for college or to directly enter the workforce.

Preparing cybersecurity talent for the cyber workforce requires hands-on learning. However, teaching authentic, hands-on cybersecurity is resource intensive. Providing access to a cyber range, virtualizations, competitions, and other tools and technologies for students to gain cybersecurity skills are costly. This also impacts what type of student has access to authentic, hands-on cybersecurity courses and programs. Schools that have resources to support these types of programs and/or those that position cybersecurity in the CTE program and can use Perkins funds are able to provide their students' access. Schools that do not have these resources either cannot provide their students opportunities in cybersecurity or provide diminished opportunities.

### Conclusion 5: Access to cybersecurity courses based on race, gender, SES, and other demographic characteristics of students is challenging to measure but there are some insights based on this study.

The study reported the percentage of students by race who attend a school with either cybersecurity, computing, or non-computing classes; not whether those classes are offered, and if so, what the student profile is of those that enroll in them. And URM is a category representing several races and because of this

grouping they are the largest percentage of students overall. We found that 27% of URM and 25% of White students attend a school with cybersecurity. Interestingly 36% of Asian students attend a school with cybersecurity.

In order to understand these findings, it is important to contextualize them by examining two factors that impact computing and cybersecurity courses: 1) CTE and 2) Advanced Placement. The findings primarily do reflect national CTE trends. Data from the National Center for Education Statistics on the federal CTE program show that white and Black students participate in at least one CTE course at about the same rate (82 percent), and their Hispanic peers participate at a rate of 78 percent. These data also show that gaps exist and worsen as students progress. Twenty-two percent, 18 percent, and 16 percent of white, Black and Hispanic students, respectively, achieved the CTE concentrator status of three CTE courses in 2013. However, some of the gateway computing courses may not be in CTE and are advanced placement courses (AP CSP and AP CSA). According to research, Black students are less likely than white students to have access to college-ready courses such as advanced placement. Black and Latino students represent just 38% of students in schools that offer AP courses, but just 29% of students enrolled in at least one AP course (AmericanProgress.org).

The finding that Asian students are the highest percentage with access to cybersecurity and gateway computing courses (except in VA) is perhaps reflective of the data that indicates Asian students earn the highest math course credit in calculus (45%) compared to white students (18%), multiracial students (11%), Hispanic students (10%), and Black students (6%). In addition, Asian students earn the most AP/IB credits (72%) followed by white students (40%), which are both higher than any other racial group. And college enrollment rates are higher for Asian students (58%) as compared to multiracial (42%), white (42%), Hispanic (39%), Black (36%), Pacific Islander (21%), and American Indian/Alaska Native (19%) (NCES, 2019). This perhaps reflects that Asian students are more likely in high schools where they have access to several electives and college preparatory classes.

In terms of other demographic characteristics, there are currently no data sources that are meaningful at the cybersecurity course or program level. Title I is an indicator of a school's population economic status. Title I is a federal program that provides financial assistance to schools with high numbers of children from low-income families. We also found that 22% of all non-Title I schools have a cybersecurity course as compared to only 11% of Title I schools that do.

# Recommendations

## Recommendation 1: Invest in gateway-to-computing courses

For states or schools with no gateway-computing courses, a recommendation is to incentivize and support these schools in developing gateway CS and IT courses. These foundational building blocks should be supported first. For states or schools with no cybersecurity and high non-gateway courses, a recommendation is to transition non-gateway courses to gateway courses. The states and schools with higher non-gateway courses have teachers, labs, and hours in the schedule already. The job ahead will be to adapt the resources and upskill the teachers to teach gateway computing in preparation for cybersecurity.

## Recommendation 2: Invest in cybersecurity courses and pathways

For states or schools with gateway courses but no cybersecurity, a recommendation is to add cybersecurity. And to do so in a manner that leverages CS gateway, as well as IT gateway. The job ahead will be to upskill teachers to teach cybersecurity and to build pathways that scaffold foundational computing knowledge (CS and IT) into cybersecurity.

## Recommendation 3: Invest in cyber ranges and virtualizations

Given lessons learned in states like Virginia, another recommendation is investment in resources such as cyber ranges, virtualizations, and other tools and technologies to enable authentic, hands-on learning in high school cybersecurity. Free or low-cost access to a cyber range is necessary for all students to have access to authentic, hands-on cybersecurity learning in their curriculum; even if they are in small, rural schools.

## Recommendation 4: Catalyze around a national set of K-12 cybersecurity educational guidelines/standards

Another recommendation to nurture the landscape for cybersecurity education is to catalyze around a national set of K-12 cybersecurity educational guidelines/standards. Educational standards would enable high schools to adopt a cybersecurity course, program and pathway where students achieve consistent learning outcomes whether they are in Maryland or Florida or Texas. The High School Cybersecurity Curriculum Guidelines is an initial effort to defining the high school cybersecurity domain and thus a recommendation is that the High School Cybersecurity Curriculum Guidelines be leveraged to further this effort. This effort would have a cascading impact on curriculum and assessment as nationally and state recognized guidelines/standards would enable teachers to align their instruction in their Cybersecurity I and II courses accordingly. In this regard another recommendation is to create more intentionally-designed inclusive cybersecurity educational materials and opportunities to interest more girls and students from underrepresented groups into the field of cybersecurity.

## Recommendation 5: Invest in teacher professional development

The lack of qualified teachers to teach cybersecurity education is a significant barrier to advancing K-12 cybersecurity education in the United States. Teachers need a depth of subject knowledge, technical skills, and appropriate instructional methods to increase their confidence and ability to effectively teach cybersecurity. Cybersecurity is often a new subject area for teachers who may or may not have computing or technical backgrounds. Teachers need access to professional development that goes beyond the introductory one-day or one-week workshops that are typically curriculum or tool-focused. Initiatives such as the National Cybersecurity Teaching Academy offering teachers the opportunity to pursue a graduate-level certificate in cybersecurity education should continue to be invested in and grow.

## Recommendation 6: Continue studying the landscape and include measurements of student demographics at the course/program level

Metrics at the classroom-level, program-level, and state-level are critical for 1) understanding the current status of K-12 cybersecurity education and 2) measuring progress. Metrics can also be used to investigate interrelationships in the cybersecurity educational ecosystem to include diagnosing gaps in the ecosystem such as structural patterns of exclusion obscured by traditional demographic analytics. This is critical if we are to address the disparities that exist concerning access to cybersecurity programs. We need to be able to drill down to the local level to understand the interplay of the several factors involved in cybersecurity education.

## Recommendation 7: Forestall establishing a designation program until more capacity is built

Cybersecurity programs have yet to take a foothold in U.S. high schools. While it is clear that some schools could be considered just based on the number of courses, considerable effort is suggested to think through quality factors. It does not appear to be the right time to allocate resources to launch a designation program given the state of high school cybersecurity education.

This said, we offer two thoughts. First, a recognition program might be more appropriate. What we mean here is a program where model schools can nominate themselves for review, and if deemed to be deserving, could be featured as *an* exemplar program. This way more than one type of program can serve as exemplary. Second, the recognition program might be framed as developmental. In this way, the program would recognize schools at different levels and offer support to reach the next level and recognition for doing so.

## Recommendation 8: Fund further research

We recommend continued support for this work. Earlier we cited the State of CS Education report that is now published annually. This report has been influential in tracking and informing public policy in the U.S. Without sound metrics, it is hard to know what interventions to start, stop or continue.

Future work should include:

- Modeling the CyberSupply chain through higher education.
- Tracking data annually.
- Expanding access to these data through informative, interactive visualizations such as those started here: cybersupply.org.

# APPENDIX D

# Comparative Study of High School Designation and Award Programs

**John Sands (PhD)**
Executive Director, Center for Systems Security and Information Assurance (CSSIA)
Department Chair, Faculty Member, Computer Integrated Technologies
Moraine Valley Community College

**Kyle Jones**
Chair, Assistant Professor, Computer Information Services
Sinclair Community College

**Andrew Lutz**
Chair, Associate Professor, Information Technology-Networking
Johnson County Community College

APPENDIX D

# Comparative Study of High School Designation and Awards Programs

## Executive Summary

### Recognition Versus Designation

In the comparative study of high school award programs, our team discovered two major types of programs, recognition versus designation. The research indicates that the type of award program implemented was based on several factors. These factors can include the purpose or goal of the program, the costs involved, the resources available to operate the program, and the potential target size of the program. One of the significant factors is the ability to manage and operate the program over a longer term. In some cases, recognition programs transitioned into designation programs. Another major factor that must be considered when comparing existing programs would be the popularity and response level to these programs. The research indicated that programs with award criteria more generally aligned to overall academic standards usually are more popular. Programs that are subject or career specific are less widely pursued.

### Recognition Programs

Recognition programs are designed to highlight outstanding institutions, administration, staff, faculty, and/or students. Many of these programs limit the number of awardees each cycle. Others were open to any institution that qualifies. Some programs are centrally or nationally managed. Other programs were locally managed. This typically meant the sponsors provided a broad framework of requirements and granted states or regions the authority or responsibility to set the selection criteria. For example, the National Blue-Ribbon award sponsored by the US Department of Education limits the number of recipients by state. Each state is required to organize a committee to manage the nomination process. In this model, more populated states get more annual recipients than less populated states. Some programs are driven by state-level nominations, while others require the institution to complete an application process. These programs typically culminate in a national event to acknowledge this institution.

**Advantages:** Recognition programs are simpler to adopt and manage and require a less operating costs. These programs can be sponsored and operated by private companies, state agencies, federal agencies, or partnerships between these stakeholders. The recognition promotes program goals like building quality academic programs of study. These programs also can bring attention to a career or technical workforce shortage and advance a career pathway. Recognition programs can motivate change and reward institutions and individuals, and provide examples of program excellence.

**Disadvantage:** Recognition programs reward excellence at a point in time. They typically do not require ongoing verification of performance. Recognition programs may not proportionally recognize the under-resourced schools and may further disadvantage students from these schools. Recognition programs are typically a one-time award and do not promote continuous improvement or contribute to building a community of excellence.

## Designation Programs

Designation programs require institutions to meet criteria to earn a designation. The designation is typically good for a specific period at which point the institution must re-designate like the CAE-CD program. These programs usually cost more to manage, require more resources, and are designed to promote continuous improvement. Designation programs are more burdensome on the applicate institutions and the designating organization. Many of these programs define multi-levels of designation, for example, 5-star, 4-star, and 3-star. They tend to encourage and assist underperforming schools to improve their programs and work toward excellence. Designation programs also can leverage the designated community to address specific needs or academic issues. Designation programs typically have some benefits for maintaining the designation.

**Advantages:** Designation programs involve continuous improvement and a long-term commitment by the institution resulting in more significant impact and improvement. Designations programs can introduce new requirements or adjust requirements to better align with the purpose and goals of the program. Designation programs can accommodate multiple levels of accomplishments and provide a framework and resources to matriculate the designation levels. These programs typically establish a community of best practices.

**Disadvantages:** Designation programs take more effort to establish, cost more to operate, and are harder to build momentum. Designation programs require institutions to assign a point of contact or champion to run the program. Designation programs require commitment and resources to maintain continuity.

## Feasibility

The research team concluded that recognition programs would be feasible, however, at this point in time a designation program would not be feasible without addressing serious concerns like establishing a program that would have the perception of an elitist program only recognizing schools and students with access to plentiful resource. A recognition program would be feasible but may not initially align with the purpose and goal. The goal is to promote excellence in high school cybersecurity programs of study and pathways program.

## Advisability

A recognition program would be advisable as a precursor to a full designation program. Establishing a full designation program would not be advisable at this point. Although there is interest in a high school designation program, the program would require significant funding. There would also need to be sensitivity and attention to building a program that was inclusive, and equitable, and resulted in improving the diversity of a national cyber security workforce pipeline.

# Full Report

## Executive Summary

Even after a decade of significant federal investment, the cybersecurity workforce shortage stubbornly persists. Most research predicts a continued growth in this labor shortage. However, there are specific examples of investments and programs that have yielded significant progress in building an infrastructure to address this problem.

One important approach the National Security Agency (NSA) pursued to tackle the problem in 1999 was the creation of the Center of Academic Excellence in Information Assurance Education (CAE-IAE) initiative. This is a post-secondary level designation and recognition program. Now, under the leadership of the NSA and the Department of Homeland Security (DHS), the program has grown to set the standard of excellence for institutions across the nation teaching cybersecurity. There are currently over 300 designated programs. As the program has grown, so has the need for more than 52 different cybersecurity work roles. For these programs to meet the rate of growth in the nation's cybersecurity workforce, the nation will need to create more high school cybersecurity programs of study. Career and technical programs of study are designed to prepare high school students for the academic pathway leading to advanced technical careers. If properly coordinated, the high school students interested in cybersecurity careers are better prepared and can be guided to enroll in one of the many CAE institutions.

According to a survey of state department of education websites, most states are offering cybersecurity-related instruction ranging from networking to cybersecurity foundations (UAH, 2020). However, this data may be misleading. Some of these programs may only exist on paper. While others include cybersecurity topics but may fail to prepare high school students for college cybersecurity programs. The challenge is encouraging high school cybersecurity educators to establish programs that are rigorous, address the workforce skills gap, feed the nation's pipeline of cybersecurity professionals, and better align to the CAE network.

One possibility to support high school cybersecurity education is the creation of a High School Cybersecurity designation or recognition program that emulates applicable features of the Centers of Academic Excellence in Cyber Defense. This study will address the following questions: Is a high school designation or recognition program an advisable and feasible approach to further support the much-needed cybersecurity education to career pipeline? What would be appropriate criteria for such a program? What would the program require in financial and administrative support? Would high school educators have an interest in earning such a designation or recognition?

To answer these and many other related questions, the research team is performing a feasibility and advisability study. The first part of this study is a comparative analysis of other existing high school designation and recognition programs. The following report is a summary of the findings of this study.

# Research Methodology

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. This comparative study examined several existing high school designation and recognition programs. These programs include student, faculty, administration, and institution designations and recognitions. The research team deployed three methods of collecting information to be analyzed:
The team searched for, compiled, organized, and analyzed internet-based information in documents from some of the most popular high school designation and recognition programs.

Researchers interviewed applicants and recipients of these designation and recognition programs.
The research team also attended conferences and events that recognize recipients and bring together the program participants. The research team developed systematic methods to identify questions and types of data that would be most useful in completing a comparative analysis. Program characteristics including purpose, goals, size, and perception were gathered. The following report summarizes each of the programs and compares relevant elements of each program.

# Study Rational

The National Security Agency (NSA) Department of Homeland Security Center of Academic Excellence in Information Assurance Education (CAE-IAE) Program was launched in 1999 with just seven colleges. Initially, the program only recognized four-year colleges and universities. As the program evolved, it was also expanded to include community colleges. Today, there are over five hundred schools that are recognized.

## A Brief History of the NCAE-C Program

In 1999, the National Security Agency (NSA) launched the Center of Academic Excellence in Information Assurance Education (CAE-IAE) program. Under this program, an institution could receive the CAE-IAE designation if it passed rigorous curriculum and program requirements.

- May 1999, seven schools became designated as a CAE-IAE, and soon, many more institutions joined the ranks of CAE-IAE designated institutions. While the CAE-IAE program initially formed to address the shortage of intelligence community professionals, the program later expanded to address the lack of qualified cybersecurity professionals in the workforce
- In 2004, the Department of Homeland Security (DHS) became a co-sponsor of the CAE-IAE program
- In 2008, the program added a cyber research designation (CAE-R)
- In 2017, the CAE-IAE designation was changed to the CAE in Cyber Defense Education (CAE-CDE)
- In 2019, a designation for two-year colleges (CAE-2Y) was added
- In 2020, the CAE-2Y designation was merged with the CAE-CDE designation and changed to the CAE in Cyber Defense (CAE-CD) designation

- Today, the NCAE-C program has over 300 institutions all over the Nation with designations in Cyber Defense (CAE-CD), Cyber Research (CAE-R), and Cyber Operations (CAE-CO)

### What is a Center of Academic Excellence in Cybersecurity (CAE-C)

Institutions that receive a CAE-C designation have met the rigorous requirements set forth by the sponsor of the program, the National Security Agency (NSA). The NSA awards CAE-C designations to institutions that commit to producing cybersecurity professionals that will reduce vulnerabilities in our national infrastructure. There are three types of designations schools can pursue: Center of Academic Excellence in Cyber Defense (CAE-CD), Center of Academic Excellence in Cyber Research (CAE-R), and Center of Academic Excellence in Cyber Operations (CAE-CO). While the NSA does not provide funding to CAE-C designated institutions, once a school obtains one of these designations, it can compete for grants like the Department of Defense Cybersecurity Scholarship Program (DoD CySP) and can also apply for the National Science Foundation's (NSF) Scholarship for Service program. Schools are not limited to a single designation and are encouraged to pursue more than one.

The CAE community has experienced some growing pains over the years as a result of the evolution of the program. The next logical expansion is to establish and recognize partnerships with local high schools. The lifeblood of most college career programs is the partnership between the Career and Technical Education (CTE) programs, Computer Science, Pre-Engineering programs and their local high schools. These partnerships provide high school students with a program of study that leads to associated technical careers.
A high school designation and recognition program could be used to help CAE institutions build a national network of cybersecurity programs of study that rival equivalent programs in health sciences, criminal justice, manufacturing, and automation programs.

# Study Purpose

The purpose of this sub-study is to identify and research k12-Academic recognition programs to be used when determining the feasibility of a new cybersecurity associated designation program. The team will identify 8-10 programs, research these programs and generate a report summarizing our findings. The comparative and contrast study will example the following:

- What is the stated **purpose** or **mission** of the program?
- What is the **governance** model?
- What is the **funding** and **sponsorship** model?
- What is the **membership size** of the program?
- What are the **associated costs** of the program?
- What are the **criteria** of evaluation?
- How is the **designation announced** and or awarded?
- What are the **benefits** of earning the designation?
- What is the **framework** and or structure of the designation
- What is the overall member's **perception** of the designation?

- How is the program **promotion**?
- What is the **length** or **requirements** to maintain the designation status?
- Is there an **application process** or nomination or both?
- Does it serve both **public** and **private** schools?

# Data Collection

The data collection is the process of gathering and measuring information on targeted variables in an established process. The results will enable our team to answer relevant questions and provide insight and the experience of others in the overall feasibility study.

- Do documents and web-based research
- Interviews with the K12 high school community leaders and program participants
- Visit with leaders at conferences and events
- Construct and disseminate survey instruments

## Report Framework

- Introduction
- Date Establish
- Size
- Sponsoring Organization
- Research Data

## Academic Programs Considered

- National Blue Ribbon Schools - US Department of Education
- Blue Ribbon Schools of Excellence - Blue Ribbon Schools of Excellence Inc
- Governor's Designated STEM Schools (Multiple States) Platinum Schools
- National Certifications for Robotics and Advanced Automation Manufacturing (NOCTI)
- Southern Regional Education Board's (SREB) High Schools That Work (HSTW)
- Project Lead the Way (PLTW) Distinguished Schools
- League of Innovative Schools – Digital Promise Program
- National Academy Foundation (NAF) Future Ready Schools
- California Distinguished Schools Program
- U.S. Presidential Scholars in Career and Technical Education Program
- CTE Cybernet Schools US Department of Education
- National PTA School of Excellence
- Amazon Future Engineer Program
- Global School Alliance
- Green Ribbon Schools
- Purple Star Campus Designation

# Part I: Summary of High School Programs

## NATIONAL BLUE RIBBON SCHOOLS PROGRAM

### Program Overview

The National Blue Ribbon Schools Program is a United States Department of Education award program that recognizes exemplary public and non-public schools on a yearly basis. Using standards of excellence evidenced by student achievement measures, the Department honors high-performing schools and schools that are making great strides in closing any achievement gaps between students. The U.S. Department of Education is responsible for administering the National Blue Ribbon Schools Program, which is supported through ongoing collaboration with the National Association of Elementary School Principals, Association for Middle Level Education, and the National Association of Secondary School Principals. Since the program's founding, the award has been presented to more than 9,000 schools.

### Purpose/Goal

Now in its 38th year, the National Blue Ribbon Schools Program has bestowed almost 10,000 awards to more than 9,000 schools, with some schools winning multiple awards. National Blue Ribbon Schools represent the full diversity of American schools: public schools including charter schools, magnet/choice schools, Title I schools, and non-public schools including parochial and independent schools. They are urban, suburban, and rural, large, and small, traditional and innovative, and serve students of every social, economic, and ethnic background.

### Established 1982

### Sponsor

US Department of Education, working with the National Association of Elementary School Principals and the National Association of Secondary School Principals.

### Size

The National Blue Ribbon Schools Program has awarded approximately 9,000 times, recognizing 5,200 different schools.

### Criteria

Accepts nominations of both public/non-public schools that meet one of two criteria:

1. Exemplary High Performing Schools are among their state’s highest performing schools as measured by state assessments or nationally normed tests.
2. Exemplary Achievement Gap-Closing Schools are among their state’s highest performing schools in closing achievement gaps between a school’s subgroups and all students over the past five years.

## Award Categories

**Exemplary High Performing Schools** - have their state's highest high school graduation rates and the highest achieving students (the top 15%) in English and mathematics, measured by state assessments.

**Exemplary Achievement Gap Closing Schools** - have made the greatest advances (top 15%) in closing subgroup achievement gaps in English and mathematics over the past three to five years, measured by state assessments. Non-public schools are recognized as "Exemplary High Performing" if their student achievement in English and mathematics is among the highest in the country (top 15%), measured by state assessments or nationally normed tests.

## Cost

Just the cost involved in completing the application.

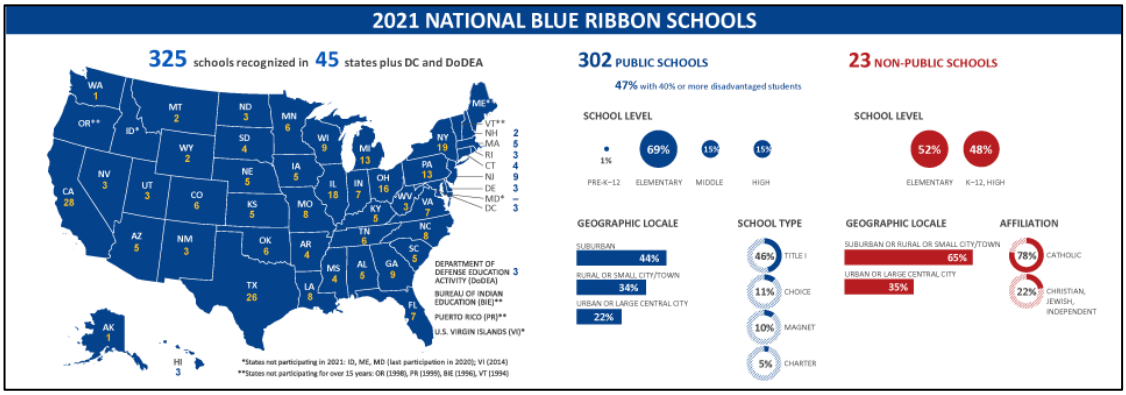
## Eligibility

Schools must have been in existence for five years and cannot have received the award within the five prior years. Must have excellence in the fields of academics, arts, and athletics.

## Application Process

A total of 420 schools are nominated each year. The Department invites National Blue Ribbon Schools nominations from the top education officials in all states, the District of Columbia, Puerto Rico, the Virgin Islands, the Department of Defense Education Activity, and the Bureau of Indian Education. Must be nominated in the state by Although at one time schools self-nominated for the award, this is no longer the case. At the invitation of the U.S. Secretary of Education, Chief State School Officers (including Washington, DC, the Department of Defense Education Activity, the Bureau of Indian Education) and the Council for American Private Education nominate eligible schools for the annual award. Eligible schools must demonstrate high or strongly improving student scores on state or nationally normed assessments in the last year tested; schools must also make Annual Yearly Progress in accordance with No Child Left Behind.

Nominated schools submit applications describing school operations such as the use of assessments and assessment data, instructional methods, curricula, professional development, leadership, and community and family involvement. A total of 420 schools may be nominated in any year; state quotas are determined by numbers of students and schools.



### Method of Recognition or Designation

Each year the award recipients are recognized at a national event. The national website also recognized each recipient.

### 2021 NBRS Awards Ceremony Highlights

The 2021 Annual National Blue Ribbon Schools Awards Ceremony on November 4th and 5th in National Harbor, Maryland brought nearly 800 educators and leaders together to recognize 325 public and private schools receiving the award. During this celebratory, two-day event, participants heard from several guest speakers, engaged in networking discussions, attended workshops, heard from 2021 Bell awardees, and joined their peers in the presentation of awards.

## BLUE RIBBON SCHOOLS PROGRAM OF EXCELLENCE

### Program Overview

Blue Ribbon Schools Program of Excellence (BRSE) was founded by Bart Teal. It is a comprehensive school self-assessment experience utilizing the Blueprint for Excellence with guidance and support from Blue Ribbon Recognized School Educators. The program assists all schools, with a special focus on low socioeconomic, culturally diverse, and low performing communities of learning in assessing the quality of their academic and instructional programs and in developing a school-wide action plan to ensure measurable student achievement. Additionally, BRSE supports effective comprehensive school reform through the development and implementation of a web-based Interactive Library of Best Practices, K-12. The BRSE Program develops and supports educational policies that improve student performance and enable comprehensive school reform. BRSE also provides a network of educators from nationally recognized Blue Ribbon Schools, as well as researchers, business leaders, philanthropists and government officials, which allows these individuals to exchange information and ideas.

### Purpose/Goal

The BRSE program employs educators from nationally recognized Blue Ribbon Schools to provide guidance for the principal, school staff, parents, and community members. These educators assist the school community in identifying key academic and instructional strengths and weaknesses of their school and elicit positive motivation needed for the school community. This enables the school community to initiate and implement a school-wide action plan for improving their academic and instructional program to ensure measurable academic achievement for all students.

### Established1999

### Sponsor

The BRSE invites corporate sponsors known as program Strategic Partners. They consist of: The Walt Disney Company, Cisco, Standard for Success, Tallo, ScreenBeam, Schlechty Center, Safari Montage, Equal Opportunity Schools, IXL, EdPower, Ignite Nation, Rex Academy, Snappet, Educational Epiphany, Advanced Facilities Solutions, and eGlass.

## Criteria

1. Student Focus and Support
2. School Organization and Culture
3. Challenging Standard and Curriculum
4. Active Teaching and Learning
5. Technology Integration
6. Professional Community
7. Leadership and Education Vitality
8. School, Family, and Community Partnerships
9. Indicators of Success

## Award Categories

- Lighthouse
- Beacon
- Points of Light

## Cost

$4,000 - $7,000

## Application Process

The schools submit an online application with specific information. From there, they fill out a Demographic Questionnaire. Then the school completed the online assessment tool. The online tool asks questions involving facilities, support staff, a sample of students, and community stakeholders. After all the information has been collected, the school submits a final report to Blue Ribbon School of Excellence for review. The final report involves an examination of Demographics Report, School Strengths Report, No Consensus Report, Critical Areas Report, Action Plan Report, Student Grade Level Report, Total Accumulation of Data Report, Lighthouse Eligibility Schematic. The school that applied hosts a two-day onsite validation review. The Blue Ribbon Schools of Excellence Assessment Consultant Assessor will meet onsite to consider the data collected from the final report. The reviewer/assessor leaves the school with an improvement plan and recognition level.

## Method of Recognition or Designation

The BRSE program awarded schools at their conference in Florida each year. Each designation school received an award representing their level of the award category. Many schools receive local news attention by being congratulated either in local news or paper in their area.

## Benefits to the Recipient Institutions

- Academic Improvement
- Involve key stakeholders in the district
- Improve morale
- A common goal for the school

# GOVERNOR'S DESIGNATED STEM SCHOOLS (MULTIPLE STATES) PLATINUM SCHOOLS

## Program Overview

Designation as a Governor's STEM School denotes that the school meets the highest standards of STEM instruction and is a model for schools around the state. For parents and the community, the designation also communicates the level of high-quality STEM education that can be expected at the school (*https://osit.nv.gov/STEM/Gov_Designated_STEM_Schools*). Most Stats offering the program say they are committed to ensuring each child is challenged, prepared, and empowered. STEM and STEAM education provides an opportunity for each child to discover and learn, pursue a fulfilling post-high school path and to become a resilient, lifelong learner who contributes to society (Ohio STEM).

## Purpose/Goal

STEM and STEAM education is an integrated approach to learning where rigorous academic concepts are learned through real-world, project-based experiences. Students use science, technology, engineering, arts/humanities, and mathematics concepts to make authentic connections between school, community, and work experiences. The Ohio STEM and STEAM School Designation was created to award and recognize schools that are exemplars of this work (Ohio STEM). In Nevada the vision is that every student in Nevada will have access and opportunities to experience a high-quality science, technology, engineering, and mathematics (STEM) education, with the ultimate objective that students are prepared to thrive in the New Nevada economy. Key to realizing this vision is the effort to encourage all schools, with a particular focus on reaching groups underrepresented in STEM, to adopt practices that engage and expose students to real-world problem solving, creative design, innovation, critical thinking, and career opportunities through STEM-focused formal and informal education (Nevada STEM).

## Established Ohio 2007, Nevada 2014

## Sponsor State

## Size

- 88 schools designated in Ohio
- 29 schools designated in Nevada

## Criteria

Each state has a STEM school Framework.

- Nevada Framework
- Ohio Framework

## Award Categories

- Nevada has a scale system consisting of Model, Established, and Developing STEM schools.
- Ohio has two school designation either a STEM or STEAM school.

### Cost

None

### Application Process

Each state has a very rigorous well developed application process.

- Nevada: <insert info>
- Ohio: <insert info>

### Benefits to the Recipient Institutions

Each state discusses the benefit to School Culture, Learning and Teaching, and Pathways to Success in Careers.

## NATIONAL CERTIFICATIONS FOR ROBOTICS AND ADVANCED AUTOMATION MANUFACTURING

### Program Overview

FANUC offers the only National Certifications for Robot Operations, Programming, Integrated Vision, and industry 4.0 Connected Smart Manufacturing. This industry-education development represents an 18-month initiative that brought together subject matter experts from industry, automation systems integrators, leading advisors and instructors from high school, community colleges, and universities all focused on preparing a pipeline of talent with the core competencies and automation technology skills for today's manufacturing industry (FANUC).

### Purpose/Goal

With these challenging and thorough national certification assessments, students and workers can document their knowledge and fill high demand, high paying, and exciting career opportunities in Robotics and Advanced Manufacturing. These national certifications are offered by an extensive network of high schools, colleges, and training centers that provide FANUC Certified Education programs with hands-on applied technology in robotics and advanced manufacturing.

### Sponsor

National Occupational Competency Testing Institute (NOCTI)

### Size

- 1,300

### Criteria

Third-party certification involves independent development and verification to reduce conflict of interest and provide significant meaning. While it is important for an individual to prove their skill level by obtaining a

third-party certification such as a FANUC Robot Operator and Technician certification, it is equally as important for the organization developing the certification assessment to be a third party (FANUC).
The assessment development company works with the Subject Matter Expert (SME) team provided by the certification organization to identify the core and critical competencies needed to become certified in a particular industry or skill set. This third-party also serves as the disinterested party of who becomes certified. Their only stake in the process is to ensure that those meeting the minimum requirements of the certification have the skills determined by the SMEs to be successful in the industry (FANUC).

## Award Categories

FANUC America, together with NOCTI developed the industry-recognized national certification programs which include two levels of FANUC Certified Robot Operator (FCR-O1 & FCR-O2) and two levels of FANUC Certified Technician (FCR-T1 & FCR-T2) indicates an operator level of skills and knowledge. These certification programs are focused on the core Operator and Technician level skills needed for student and adult education programs.

- FCR-O1 FANUC Certified Robot Operator-1: Written assessment for entry level position as robotics associate in manufacturing. The assessment exams allow the candidate to demonstrate their knowledge in: Robot operations, frame setup, writing, modifying and executing basic programs, program offset, backup, restorations, creating and modifying simulations.
- FCR-O2 FANUC Certified Robot Operator-2: Performance assessment for entry level position as robotics associate in manufacturing. The assessment exams allow the candidate to demonstrate their knowledge in: Robot operations, frame setup, writing, modifying and executing basic programs, program offset, backup, restorations, creating and modifying simulations.
- FCR-T1 FANUC Certified Robot Technician-1: Written assessment for technical level position as a robotics engineering associate in manufacturing. The assessment exams allow the candidate to demonstrate their knowledge in: Single axis mastering on all six axis, how to create and execute a pick and place program for load and unload applications, and how to set up and program 2D Integrated Vision for part offset and inspection.
    - Currently in pilot testing with Nocti

- FCR-T2 FANUC Certified Robot Technician-2: Performance assessment for technical level position as robotics engineering associate in manufacturing. The assessment exams allow the candidate to demonstrate their skills in: Single axis mastering on all six axis, how to create and execute a pick and place program for load and unload applications, and how to set up program 2D Integrated Vision for part offset and inspection.
    - Currently in pilot testing with Nocti

# SOUTHERN REGIONAL EDUCATION BOARD'S (SREB) HIGH SCHOOLS THAT WORK (HSTW)

## Program Overview

Based in Atlanta, Georgia, which works to improve education at every level in its 16 states: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee,Texas, Virginia and West Virginia. The nation's first regional interstate compact for education, SREB was founded in 1948 by governors and legislators who recognized the link between education and economic vitality.

## Purpose/Goal

The SREB was established to help states focus on what works in both policy and practice. The organization conducts research, collects and analyzes data, publishes reports and recommends actions on current and emerging issues. They bring together member states to forge consensus and work together on initiatives that would not be possible alone. We help states share scarce resources and best practices.
The cornerstone of SREB's school improvement designs, High Schools That Work connects college-ready academics, challenging career pathways and hands-on workplace learning with early opportunities for students to earn credentials and degrees, discover emerging careers and build plans to achieve their goals.

## Established

The SREB is the nation's first regional interstate compact for education, SREB was created in 1948 by Southern governors and legislators who recognized the link between education and economic vitality.

## Sponsor

SREB is a nonpartisan, nonprofit organization headquartered in Atlanta. They serve 16 states: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia and West Virginia. Their work is funded by member appropriations, as well as by contracts and grants from foundations and from local, state and federal agencies.

## Size

Offer Institute on Teaching and Mentoring, Summer Conference, Webinars to over 1500 schools.

## Criteria

1. **High Expectations** - Help teachers embrace school and classroom practices that elevate learning, promote a growth mindset and ensure each student has access to intellectually demanding course work and resources. (Leadership for Continuous Improvement)

***Indicators:***

- School leaders build teachers' capacity to implement school and classroom practices that promote a growth mindset and encourage students to achieve.
- Teachers establish classroom policies and procedures and standards-aligned instructional practices, assignments and assessments that promote high expectations.
- Teachers clearly communicate expectations to help students recognize when they are not progressing and proactively seek feedback to advance their learning.
- Teachers create rigorous assignments and assessments and use effective feedback and questioning strategies that help students meet high expectations.
- Teachers, leaders, and the whole school community regularly celebrate students' achievements.

2. **Programs of Study** - Ensure each student can develop and complete a high-quality program of study — a progressively intensive, non-duplicative sequence of secondary and postsecondary general and/or career and technical education courses, co-curricular learning experiences and accelerated learning options — that culminates in the attainment of recognized industry and/or postsecondary credentials. (Career Pathways)

   ***Indicators:***

   - Each student develops and annually reviews and revises a personalized education plan that includes rigorous academic core courses and/or challenging career pathway courses and aligns with their interests and aptitudes.
   - The school offers programs of study in career pathway areas that reflect local and regional workforce needs, as determined by analyses of workforce data.
   - Each student has opportunities to earn industry-recognized credentials and early postsecondary credits in their chosen program and career pathway.
   - Programs of study expand learning beyond the school walls by connecting students with local career and technology centers, two- and four-year postsecondary institutions, co-curricular and work-based learning options, online learning and engagement with business, industry, and community partners.
   - The school maintains active advisory committees of business, industry, postsecondary and community partners who help design and deliver programs of study and career pathways leading to high-demand jobs.

3. **Integrated Curriculum** - Help students master the essential concepts of the state's college- and career-preparatory curriculum by teaching academic content through the lens of real-world problems and projects. (Aligned Curriculum)

   ***Indicators:***

   - School leaders create a data-driven environment by providing teachers with the tools, resources and support they need to use qualitative and quantitative student data to identify and address curricular gaps.
   - Teachers unpack and align state standards with relevant, engaging instruction, assignments, and assessments.

- Teacher teams use established processes to review, analyze and select student-centered instructional tools that align with standards.
- Teachers collaborate across disciplines to integrate literacy in all courses.
- Each student learns content and academic, technical and workplace skills by completing real-world problems and projects.

4. **Access and Equity** - Ensure each student, including underrepresented and nontraditional students, has equitable access to intellectually challenging academic and technical studies that emphasize the mastery of skills needed in the workplace and further education. (Career Pathways)

   ***Indicators:***
   - School leaders, counselors and teachers ensure each student can access advanced courses and encourage students to complete challenging programs of study.
   - School leaders, counselors and teachers ensure that all academic and CTE programs are inclusive and accessible.
   - Teachers prepare lessons that reflect the lived experiences of diverse populations and acknowledge that perceptions of events are affected by race, ethnicity, culture, religion, education, gender, sexual orientation, disability, and personal experience.
   - Teachers help students consider past and current events in historical, geographical, social, and economic contexts.
   - School leaders and teachers use student and school data to identify potential barriers to success and develop plans to eliminate those barriers.

5. **Student Engagement** - Use research-based instructional strategies and innovative technology practices to actively engage each student. (Engaging Instruction)
   ***Indicators:***
   - Teachers use powerful instructional practices for literacy, mathematics, science and other curricular areas to engage students in authentic learning.
   - Teachers plan instruction after reviewing student assessment data and student work.
   - Teachers design structured opportunities for students to collaborate, engage in peer discussion and feedback, and solve real-world problems in varied instructional settings.
   - Teachers use effective classroom questioning strategies to engage students in learning.
   - Teachers use authentic project- and problem-based learning strategies to engage students in solving real-world problems.

6. **Teacher Collaboration** - Provide teacher teams with the training, time and support they need to improve instruction, align lessons with standards, create interdisciplinary assignments and develop innovative instructional practices. (Engaging Instruction)

   ***Indicators:***
   - School leaders provide time for collaborative professional learning and planning, collect data during instructional rounds and observations, review student assignments and assessments, and celebrate teachers' and students' successes.

- School leaders collaborate with teachers to create and improve curricular tools like syllabi, assessments and lesson plans that meet or exceed grade-level standards.
- School leaders provide opportunities for teacher teams to integrate lessons and assignments across disciplines and grade levels.
- Teachers collaborate with student support personnel and other staff to improve and adjust instructional supports and accelerated learning opportunities for students with Individualized Education Plans, 504 plans and other special needs.

7. **Work-Based Learning** - Encourage each student to participate in developmentally appropriate, structured work-based learning experiences that connect the classroom and the workplace and align with students' personal interests and goals. (Career Pathways)

   ***Indicators:***
   - Students participate in a broad and progressively intensive array of work-based learning experiences that allow them to explore career options, such as field trips, guest speakers, career fairs, job shadows, school-based enterprises, simulated workplaces, paid or unpaid internships, and apprenticeships.
   - School leaders and teachers engage business, industry, postsecondary and community partners in contributing to the school's curriculum, offering work-based learning, participating in classroom activities and mentoring students.
   - The school uses written agreements to define the roles and responsibilities of business, industry, postsecondary and community partners who offer work-based learning and make other contributions to the curriculum.

8. **Guidance and Advisement** - Involve the whole school community in creating and offering personalized career guidance, advice and social-emotional supports that empower students to pursue a full range of career and college options. (Systems of Support)

   ***Indicators:***
   - The school designs and implements programs that provide students and parents with social-emotional support.
   - The school offers career interest and aptitude inventories, surveys and other tools that allow students to explore their talents, consider their options and plan for the future.
   - Each student is partnered with a caring adult, such as a counselor or teacher-adviser, who regularly meets with them and serves as a contact between school and family.
   - Each student designs a personalized plan of study and collaborates with their parents, counselor, and teacher-adviser to choose courses that align with that plan.
   - The school embraces trauma-informed practices that nurture and support students who have experienced or are currently experiencing trauma.

9. **Interventions and Enrichments** - Design tiered systems of extra help and accelerated learning opportunities that help each student become an independent learner and complete a challenging academic and technical program of study. (Systems of Support)

***Indicators:***

- The school employs a system of tiered interventions for students who need academic, social-emotional, or behavioral support.
- School leaders, counselors and teachers use early warning systems and other structures to identify and monitor students who fall behind their peers, target struggling students with timely and effective interventions, and monitor student progress.
- Teachers use innovative technology tools and strategies to support learning.
- Schools regularly share information on available interventions and student progress with students and families.
- Schools provide enrichment opportunities for students who are performing on or above grade level.

10. **Culture of Continuous Improvement** - Engage the whole school community in continuously analyzing data to identify problems of practice, devise action plans for solving those problems and monitoring student learning outcomes. (Leadership for Continuous Improvement)

***Indicators:***

- School leaders engage the whole school community in developing and communicating the school's vision and mission.
- School leaders employ a distributed leadership approach to engage teams of teachers, counselors, and other staff in using SREB's problem-solving process — based on Deming's Plan-Do-Check-Act approach — to strategically plan for school improvement.
- School leaders use school, classroom, and process data to make effective decisions and monitor progress toward meeting bold goals for student achievement and school improvement.
- School leaders align ongoing professional learning opportunities with school improvement priorities and teacher evaluation data.
- School leaders develop a plan to effectively support new teachers that includes mentorships, specialized professional learning and time to collaborate with other new teachers.

## Award Categories

Making Schools Work Conference, SREB will recognize outstanding middle grades schools, high schools and technology centers that have implemented SREB's school improvement frameworks and are achieving success in meeting bold goals related to graduation, readiness, and credential attainment.

## Cost

No Cost Sponsored by governors and published materials.

## Eligibility

Open but must be nominated.

## Application Process

Nomination and the application require detailed information on all ten criteria.

### Method of Recognition or Designation

- Educators honored at high schools that work conference
- Excellence in Action Awards

### Benefits

Members receive access to research, publications, and faculty development. The group also pool institution for saving in insurance and other services.

### Perception of the Program

Pushed by the governor's office in each state. Varies by state.

## PROJECT LEAD THE WAY (PLTW) DISTINGUISHED SCHOOLS

### Program Overview

PLTW Distinguished Program Recognition celebrates districts and schools committed to helping students own their education by increasing student access, engagement, and achievement in their PLTW programs. These districts and schools empower their students to unlock their potential by developing the in-demand, real-world knowledge, and skills necessary to thrive in life beyond the classroom.

Through PLTW programs, students develop the in-demand knowledge and transportable skills that they will use in an evolving world with any career path they choose. As PLTW students' progress through grades PreK-12, they are empowered to engage in problem-solving and process thinking, develop technical knowledge and skills, build communication skills, and explore career opportunities.

### Purpose/Goal

PLTW Distinguished Program Recognition celebrates districts and schools committed to helping students own their education by increasing student access, engagement, and achievement in their PLTW programs.

### Established 2018

### Size

- Over 2,400 schools have received awards

### Criteria

**Distinguished district:** 20 percent or more of the students in each grade, K-12, participate in a PLTW program during the previous school year

**Distinguished schools:**

- *PLTW Launch Program (K-5)*
  - Your school offered at least one PLTW Launch module in each grade (K-5) during the 2019-20 school year.
  - At least 75 percent of students in your school participated in at least one PLTW Launch module during the 2019-20 school year

- *PLTW Gateway Program (6-8)*
  - Your school offered at least one PLTW Gateway unit in each grade (6-8) during the 2019-20 school year.
  - At least 50 percent of students in your school participated in a PLTW Gateway unit during the 2019-20 school year.
  - At least 25 percent of students who participated in a PLTW Gateway unit during the 2019-20 school year also participated in at least one other PLTW Gateway unit (two or more units total) during their tenure at your school.
  - Your school has strategies and/or procedures in place to support reasonably proportional representation with regard to race, ethnicity, poverty, gender, etc.

- *High School Program (9-12)*
  - Your school offered, and had students enrolled, in at least three PLTW High School courses from any pathway during the 2019-20 school year.
  - At least 25 percent of students in your school participated in PLTW High School courses from any pathway during the 2019-20 school year OR at least 33 percent of those students who participated during the 2019-20 school year took at least two PLTW courses during their tenure at your school.
  - Your school has strategies and/or procedures in place to support reasonably proportional representation with regard to race, ethnicity, poverty, gender, etc.

## Cost

The Participation Fee is assessed annually, and this is our first fee increase in six years. The new fee structure is $3,200 for PLTW Engineering, $2,200 for PLTW Biomedical Science and PLTW Computer Science, and $950 for PLTW Gateway and PLTW Launch. High schools can offer all three high school programs for a total Participation Fee of $5,400. Nonprofit post-secondary institutions offering PLTW to either secondary or post-secondary students will pay the same Participation Fee as secondary schools.

## Eligibility

PreK-12 programs that meet the criteria and apply.

## Application Process

The PLTW Distinguished District and School Program Recognitions are one-year designations. Districts and schools can submit eligibility forms every year for consideration.

### Method of Recognition or Designation

See benefits.

### Benefits to the Recipient Institutions

Following are the benefits of becoming a PLTW Distinguished School:

- Acknowledgement on the PLTW website as part of the PLTW Distinguished School listing
- Special PLTW Distinguished School designation brand logo to use on the school website and in print materials
- Sample press release for local promotion and media opportunities
- Sample social media posts for digital channel promotion
- Consideration for inclusion in PLTW communications
- Additional benefits may be added and communicated when we issue the recognition

## LEAGUE OF INNOVATIVE SCHOOLS – DIGITAL PROMISE PROGRAM

### Program Overview

Digital Promise program is described as working at the intersection of education leaders, researchers, and entrepreneurs and developers to improve learning with the power of technology. It was established in 2011 as a partnership with the White House.

### Purpose/Goal

Our new strategic approach emphasizes building on our existing strengths and relationships to achieve greater outcomes for all learners, especially those who have been excluded from full participation in the system. Focusing on education transformation that directly addresses students at the systems level—considering the impact of their communities and environments—will create more equitable educational experiences that help prepare all students for lifelong success.

- Design, validate, champion, and scale effective, innovative learning opportunities to advance equity and excellence for every student
- **Design:** Create policies, programs, tools, and models
- **Validate:** Inform design and efficacy with research
- **Champion:** Advocate for policies, programs and models that transform systems
- **Scale:** Share and drive adoption models for replication
- **Effective:** Proven positive impact
- **Innovative:** New or improved solutions to challenges
- **Advance Equity:** Ensure historically underserved student populations participate, benefit, and thrive
- **Advance Excellence:** Support solutions that increase knowledge and skills for student success

## Established

In 2011, Digital Promise launched the League of Innovative Schools, a national coalition of school superintendents. The League represents a wide array of school districts—large and small, urban and rural, low-income and middle-class.

## Sponsor

The League of Innovative Schools was launched at the White House under President Barack Obama within the U.S. Department of Education.

## Size

League members represent 125 districts in 35 states serving more than 3.8 million students. Their diverse experiences reflect the advancements, challenges, and vital work of public education in the United States.

## Criteria

Superintendents are the core members of the League. However, superintendents may invite other members of their district team to participate in League activities. Membership in the League is for superintendents who demonstrate a proven track record and/or willingness to:

- Improve outcomes for students and solving the challenges facing K-12 schools through powerful and smart use of learning technologies
- Use their collective voice to advance positive change in public education
- Partner with entrepreneurs, researchers, and leading education thinkers and serves as a testbed for new approaches to teaching and learning
- Commit to delivering educational equity for every student, everywhere
- Members of the League are selected through a two-part application process and sign the membership charter upon joining

Candidates are selected based on the following factors:

- Vision and key achievements
- Potential for impacting student learning and educational leadership
- Openness to networking and knowledge sharing
- Demonstrated commitment to racial, digital, and educational equity

## Award Categories

- Digital Innovation in Learning Awards
- Educator Winners
- Administrator Winners
- Organization Winners

## Cost

No cost involved, funded by the Department of Education.

## Eligibility

Members submit a 3-minute video demonstrating their practice for awards like Busting Boundaries, Open Door Policy, and Research@Work. The winners are selected by the judges prove that teachers, administrators, and organizations everywhere are using technology to engage and inspire learning every single day.

These winners are celebrated at a gala event in November each year in Silicon Valley.

## Application Process

Applications for the 2021-2022 cohort of the League of Innovative Schools open on February 15, 2021. The application deadline has been extended to 11:59 p.m. PT on May 21, 2021. The new member application process will follow the timeline detailed below:

- **Round One: Application**
  - Applicants submit a written application with multimedia artifacts to validate and supplement their responses.

- **Round Two: Interview**
  - Finalists will participate in two interviews —one with a Digital Promise staff person and one with a member of the League Advisory Board. In addition, Digital Promise staff may request and conduct additional interviews with district staff members.

- **Who Should Apply**
  - Superintendents are the core members of the League. However, superintendents may invite other members of their district team to participate in League activities. Membership in the League is for superintendents who demonstrate a proven track record and/or willingness to:
    - Improve outcomes for students and solve the challenges facing K-12 schools through powerful and smart use of learning innovations and technologies
    - Partner with researchers, entrepreneurs, and leading education thinkers to pilot new approaches to teaching and learning
    - Use their voice to advance positive, lasting change in public education
    - Commit to delivering educational equity for every student, everywhere

- Candidates are selected based on the following factors:
  - Vision and key achievements
  - Potential for impacting student learning and educational leadership
  - Openness to networking and knowledge sharing
  - Demonstrated commitment to racial, digital, and educational equity

Successful candidates are committed to achieving equity in public school systems, have a demonstrated record of district and community impact, and deeply respect and value diversity of voices, perspectives, and experiences.

# NATIONAL ACADEMY FOUNDATION (NAF) ACADEMIES

## Program Overview

The NAF network serves more than 110,000 students in 620 NAF academies across 34 states, plus DC, Puerto Rico, and the US Virgin Islands. This vast national community includes thousands of teachers, administrators, and district leaders who are committed to student success. Our partners in the education sector benefit from access to our career-focused curricula, support from our national staff, in-person and virtual professional development opportunities, resources for cultivating business partnerships, and much more.

School districts interested in career and technical education pathways partner with NAF to access the support they need to take their vision to the next level. We believe every single high school in our country should be preparing students for their future careers. When you work with NAF, the possibilities for your school district—and your students—are endless.

## Purpose/Goal

NAF academies are structured as small, focused learning communities that fit within and enhance high school systems, allowing NAF to become an integral part of a plan for higher achievement at low cost. NAF promotes open enrollment for its academies in order to maximize every student's chance at a successful future. The flexible structure encourages teacher collaboration across subject areas and fosters personalization to meet student, school, district, and state needs and goals.

NAF provides rigorous, career-focused curricula that incorporate current industry standards and practices, project-based learning, and performance-based assessment. NAF empowers teachers to expand the classroom boundaries by exposing students to real-world issues in career-focused industries through connections with industry professionals and the business community. Students acquire essential workplace skills and 21st-century competencies to be future-ready for college and career.

NAF's Program of Study embraces the US Department of Education's 16 career clusters and provides curricular options for students to achieve NAFTrack Certification, NAF's employability credential that serves as NAF's seal of college and career readiness. NAF academies offer multiple career pathways and enhance the academic rigor of their program of study by applying for dual enrollment/early college and state-approved, career-cluster courses to meet the curricular requirements of NAFTrack Certification.

## Established 1980

## Size

NAF is a dynamic network of 620 career academies that assist students in achieving their potential by igniting their passion for learning, engaging them in career opportunities, and preparing them for success in life.

## Criteria

NAF offers two options for entry to the NAF network:

1. Year of Planning Program: District/schools that wish to start a career academy and have little or no experience in creating a career-focused program.
2. Fast Track Program: District/schools with a functioning career academy that implements most of the NAF standards of practice, are NCAC or Linked Learning Certified, or are advanced in the academy planning process and wish to add new NAF academies should apply through NAF's Fast Track Program.

## Award Categories

Not an award program, but a program where schools partner with NAF and become academies to support their students.

## Cost

Annual membership fee: $2,000

The Year of Planning (YOP) Program is a developmental process for implementing a NAF academy that takes approximately one school year. NAF academy portfolio managers provide guided technical assistance to align academy resources and programs to ensure that all NAF's educational design elements are in place before an academy opens in the launch year.

The Fast Track Program allows a functioning academy that implements most of NAF's standards of practice to enter NAF's network as an open academy with full membership. NAF academy portfolio managers guide the Fast Track self-assessment process that assists existing academies in analyzing academy strengths and challenges in implementing NAF's educational design. The program includes an academy assessment, a review of evidence collection, and a verification meeting. The YOP and Fast Track pricing is an application fee that supports the intensive planning process provided by NAF. Upon completion of the YOP and Fast Track programs, academies move to an open academy status. Note: An academy becomes an active member when the annual membership fee is paid for the designated launch year.

- Year of Planning Program: $12,000
- Fast Track Program: $4,000

## Eligibility

Any district or school that wants to start an NAF career academy

## Application Process

Complete the NAF Interest Survey to determine readiness to meet NAF's expectations. Acceptance is currently limited.

### Benefits to the Recipient Institutions

- Academy development support that focuses on the four elements of the NAF educational design: Academy Development & Structure, Curriculum & Instruction, Advisory Board, and Work-Based Learning
- NAF's Program of Study initiative that promotes nationally recognized career clusters and their associated career pathways to maximize students' opportunities for achieving NAFTrack Certification
- Industry-validated and career-focused curricula that incorporate current industry standards and practices, project-based and work-based learning, and STEM integration
- Data-driven support to track student outcomes, academy goals, and strategic action steps for continuous improvement
- NAF sponsored professional learning experiences to support academy development
- Virtual and in-person support from NAF academy portfolio managers to ensure the development of high-quality NAF academies
- Marketing and communications support and resources for publicity, branding, and marketing
- National scholarships opportunities
- National awards and recognition

## CALIFORNIA DISTINGUISHED SCHOOLS PROGRAM

### Program Overview

Honors some of California's most exemplary and inspiring public schools. Schools selected for the Distinguished School Award demonstrate significant gains in narrowing the achievement gap.

### Purpose/Goal

A component of the California School Recognition Program (CSRP), the California Distinguished Schools (DS) Program recognizes schools that demonstrate exemplary achievements. The California DS Program recognizes elementary and middle and high schools in alternate years and allows eligible schools to apply for the California DS Award once every two years. Schools recognized as a California DS Awardee hold the DS Title for two years.

### Established 1985 (cde.ca.gov)

### Sponsor

California School Recognition Program has a nine-level sponsors organization:

| | | | | | |
|---|---|---|---|---|---|
| **Presenting Sponsor** | California Casualty | | | | |
| **Sapphire** | SchoolsFirst Federal Credit Union | | | | |
| **Diamond** | California State Lottery | | | | |
| **Gold** | California Teachers Association | | | | |
| **Silver** | Belkin International, Inc. | California Association of School Business Officials | California Masonic Foundation | California School Employees Association | Office Depot, Inc. |
| **Bronze** | Brandman University | | California Teachers of the Year Foundation | | |
| **Copper** | Association of California School Administrators | | California Credit Union | | |
| **Partner** | Californians Dedicated to Education Foundation | | | | |

## Size

223 (in 2021, schools must re-apply every two years)

## Criteria

Eligible schools in the middle and high school cycle were selected within the following two categories:

**Category 1: Closing the Achievement Gap**

- Middle School Criteria
  - At least 40 percent of the student population is Socioeconomically Disadvantaged on both the 2018 and 2019 Dashboards.
  - Highest percent of growth that met standard in English Language Arts OR Mathematics on the 2019 Dashboard for any of the targeted student groups (African American, Hispanic, Socioeconomically Disadvantaged, Students with Disabilities, Foster Youth, Homeless, and/or English Learners)
  - The ALL student group must be Blue/Green for both the English Language Arts and Mathematics Indicators on the 2019 Dashboard.
  - The ALL student group must be Blue/Green/Yellow for the Suspension Rate Indicator on the 2019 Dashboard.
  - The ALL student group must be Blue/Green/Yellow for the Chronic Absenteeism Indicator on the 2019 Dashboard.
  - At least 95 percent participation rate in both the 2017–18 and 2018–19 school years for both English Language Arts and Mathematics.

- High School Criteria (Includes K–12, 9–12 designation, or any other high school designation.)
  - All the Middle School Criteria (Except the Chronic Absenteeism Indicator)
  - The ALL student group must be Blue/Green/Yellow for the College/Career Indicator on the 2019 Dashboard.
  - The ALL student group must be Blue/Green/Yellow for the Graduation Rate Indicator on the 2019 Dashboard.

**Category 2: Exceptional Student Performance**

- Middle School Criteria
  - The ALL student group must be Blue/Green for both the English Language Arts and Mathematics Indicators on both the 2018 and 2019 Dashboards.
  - The ALL student group must be Blue/Green for the Suspension Rate Indicator on the 2019 Dashboard.
  - The ALL student group must be Blue/Green for the Chronic Absenteeism Indicator on the 2019 Dashboard.
  - At least 95 percent participation rate in both the 2017–18 and 2018–19 school years for both English Language Arts and Mathematics.

- High School Criteria (Includes K–12, 9–12 designation, or any other high school designation.)
  - All the Middle School Criteria (Except the Chronic Absenteeism Indicator)
  - The ALL student group must be Blue/Green for the College/Career Indicator on the 2019 Dashboard.
  - The ALL student group must be Blue/Green for the Graduation Rate Indicator on the 2019 Dashboard.

## Award Categories

There are two categories they are Closing the Achievement Gap and Exceptional Student Performance. The criteria for each category are listed above.

## Cost

No cost

## Eligibility

In 2021 California is recognizing outstanding education programs and practices in middle and high schools. California is using a multiple measures accountability system to identify eligible schools based on their performance and progress on the state indicators as specified on the California School Dashboard (Dashboard). Information regarding the Dashboard is provided on the California Department of Education (CDE) California School Dashboard and System of Support web page.

## Application Process

Details about the California Distinguished Schools application are issued from the California State Superintendent of Public Instruction and disclosed to School Principals, County and District Superintendents, and Charter School Administrators. Schools communicate with their County Coordinator for the California School Recognition Program to submit the application.

## Method of Recognition or Designation

California School Recognition Program Awards Ceremony

### Perception of the Program

In 2001, the Los Angeles Times wrote an article identifying complaints with the program's selection process. Times author Jessica Garrison wrote that, at the time, the application process required that "schools must score in the top half of the state's Academic Performance Index and write an exhaustive, 10-section application describing everything from campus culture to library services." The critique primarily focused on the lack of incentive, resources, and recognition for lower-performing schools that make significant improvements. The article also lamented the lack of rigorous data to back applicants' claims of student success.

## U.S. PRESIDENTIAL SCHOLARS IN CAREER AND TECHNICAL EDUCATION PROGRAM

### Program Overview

The mission of the program is to recognize outstanding high school seniors. More than 7,500 seniors have been honored since the program began.

### Purpose/Goal

The U.S. Presidential Scholars Program was established in 1964, by executive order of the President, to recognize and honor some of our nation's most distinguished graduating high school seniors. In 1979, the program was extended to recognize students who demonstrate exceptional talent in the visual, creative, and performing arts. In, the program was again extended to recognize students who demonstrate ability and accomplishment in career and technical education fields. Each year, up to 161 students are named as Presidential Scholars, one of the nation's highest honors for high school students.

### Established

2015 for CTE

### Sponsor

U.S. Department of Education

### Size

Each year every state Department of Public Instruction (DPI) sends an email to every eligible high school principal asking them to nominate students for the U.S. Presidential Scholars Program. They ask for one nomination in the "Achievement and Overcoming Challenges" category (Category 3) and one nomination in the "Achievement and CTE Accomplishment" category (Category 4). All high school seniors graduating between January and August who are U.S. citizens or legal permanent residents and attend public, parochial, or independent schools or are home-schooled are eligible.

## Criteria/Eligibility

For the general component of the program, students who meet the following criteria:

- Are or will be U.S. citizens or Legal Permanent U.S. Residents by the application deadline (Students who were not U.S. citizens or Legal Permanent U.S. Residents on the day they took SAT or ACT exam, or who requested that The College Board or ACT not release their scores to outside entities, should contact the U.S. Presidential Scholars Program at 507-931-8345 to ensure their scores are considered in the determination of the candidate pool.)
- Graduate or receive a diploma between January and August of 2022, the current program year
- Score exceptionally well on either the SAT of the College Board or the ACT of the American College Testing Program, based on tests taken during the year window that begins in September 2018 and runs through October 2021, (for the recognition cycle concluding in June 2022), nominated by their Chief State School Officer (CSSO) or nominated by one of our partner recognition organizations based on outstanding scholarship

For the CTE component of the program, students who meet the following criteria:

- are or will be U.S. citizens or Legal Permanent U.S. Residents by the application deadline
- graduate or receive a diploma between January and August of 2022, the current program year
- demonstrate academic achievement in career and technical programs
- are nominated by their state's Chief State School Officer

Application for the U.S. Presidential Scholars Program is by invitation only. Students may not apply individually to the program or be nominated (outside of the above process).

## Award Categories

US Presidential Scholars; Distinguished Teachers, receive a Presidential medallion, in commemoration of their achievements during a National Recognition event.

## Cost

None

## Application Process

https://www2.ed.gov/programs/psp/legislation.html

# CTE CYBERNET SCHOOLS US DEPARTMENT OF EDUCATION

## Program Overview

To help increase the supply of cybersecurity professionals, the U.S. Department of Education (ED) launched the CTE CyberNet — a national professional development initiative and network of high school educators. ED coordinated the development of CTE CyberNet with multiple Federal Government partners, including the NICE program office. CTE CyberNet aims to increase the number of career and technical education (CTE) high school teachers who can effectively prepare students for cybersecurity education and careers. Through CTE CyberNet, teachers can enhance their technical and pedagogical abilities to teach rigorous coursework aligned with the NICE Framework. In addition, they can discover connections to local and national cybersecurity employers and industry stakeholders.

## Purpose/Goal

The goal of the CTE CyberNet is to increase the number of career and technical education (CTE) teachers who can effectively prepare students for cybersecurity education and careers. Through a localized academy approach, teachers will gain strategies and tools to deliver more rigorous, standards-aligned CTE cybersecurity programs of study, which prepare students for postsecondary education and/or work-based cybersecurity learning. Academies are designed to help educators impart the knowledge, skills, and abilities outlined in the National Initiative for Cybersecurity Education (NICE) framework, as defined by the National Institute of Standards and Technology (NIST).

Additionally, CTE CyberNet outcomes will align with knowledge units of Centers of Academic Excellence (CAEs) to facilitate future postsecondary integration, including access to dual-credit or other postsecondary opportunities for teachers and students. Finally, effective academies will enable teachers to integrate learnings into CTE cybersecurity programs of study.

## Established 2020

## Sponsor

US Department of Education - In addition to local instruction, teachers across academies convened for a series of virtual panels exclusively for CTE CyberNet. The first highlighted the federal commitment to cybersecurity education and featured representatives from ED, NIST, NSA, and DHS. Speakers provided examples of interagency collaboration, shared federally sponsored resources for cybersecurity educators, and recognized the critical role of high school teachers in addressing one of the nation’s most pressing strategic priorities. In the second panel, leaders from Mastercard, Northrop Grumman, and Offensive Security shared private-sector perspectives on workforce needs and their strong support for rigorous secondary education in cybersecurity. Their insights, as well as support provided at the local level from Amazon Web Services and Kali Linux, helped teachers see the value and importance of their work. As the summer intensive sessions concluded, teachers heard from a panel of current students and early-career professionals and joined virtual networking sessions to get to know their peers from other academies.

## Size

5 Camps

More than 100 teachers in proximity to the three CRRCs applied to the 2020-21 academies. In June, each CTE CyberNet academy began its summer intensive session with 10 teachers. The teachers undertook 80 hours of rigorous, virtual professional development delivered by instructors from the CRRCs. The coursework and activities included technical content such as network security analysis, encryption, and hardware scans, as well as emerging topics, including AI, blockchain, and quantum computing. Teachers also became familiar with hands-on learning practices like interactive activities, challenges, and simulations. Many are integrating these topics and approaches into new cybersecurity courses for their classrooms, and some are pursuing dual-credit agreements with local community colleges.

## Criteria

CAE Regional Resource Centers Leading Inaugural CTE CyberNet Academies:

- Moraine Valley Community College, Dakota State University, San Antonio College

## Award Categories

Teach recognition.

## Cost

High School teachers who enroll in the CTE Cybernet received:

A $1500 stipend

- A full year of personalized mentorship and curriculum support from experts
- Access to a national network of cybersecurity teachers
- Recognition for excellence in cybersecurity education

## Eligibility

With input from subject matter experts, ED identified three Centers of Academic Excellence (CAE) Regional Resource Centers (CRRCs) to design, host, and lead the inaugural cohort of local CTE CyberNet academies during summer 2020 and the 2020-21 academic year. The three CRRCs were selected to lead the academies because of their experience hosting professional development programs and assisting other CAEs. The three 2020-2021 CTE CyberNet academies are being hosted by Moraine Valley Community College, Dakota State University, and San Antonio College. Each CRRC is bringing CTE CyberNet to life through localized programming and industry connections that reflect the region's specific education and employment needs. While each local academy is different, all are delivering rigorous instruction, maintaining ongoing support throughout the academic year, and building a well-networked community.

## Application Process

The three regional CAE centers were asked to identify potential participants.

### Method of Recognition or Designation

The first cohort of CTE CyberNet teachers are participating in local professional development academies. Participants will attend a summer intensive session, which will include approximately 80 hours of professional development. The session is designed to increase technical knowledge and help participants develop teaching and learning practices appropriate for their respective classrooms.

Participants will continue their professional development in an accelerator throughout the 2020-2021 academic year. The academy accelerators will provide additional resources and technical assistance to support teachers as they implement learnings and practices in the classroom. Participating teachers have the opportunity to share learnings and experiences with teachers participating in other local academies as part of the CTE CyberNet teacher network. Based on recommendations from cybersecurity subject matter experts, the U.S. Department of Education identified three CAE Regional Resource Centers (CRRCs) to host academies during summer 2020 and the 2020-21 academic year.

### Benefits to the Recipient Institutions

Building cybersecurity Programs of Study (POS) in cybersecurity.

### Perception of the Program

The program was well received, and the program will be expanding and will have financial support from NSA.

## NATIONAL PTA SCHOOL OF EXCELLENCE

### Program Overview

National PTA School of Excellence recognition program opens the lines of communication and critical thinking within school communities to make data-driven decisions that yield positive, long-term results. School of Excellence is committed to supporting and recognizing partnerships between local PTAs and schools to enrich the educational experience and overall well-being for all students.

### Purpose/Goal

Over 40 years of research shows increased family engagement is linked to school improvement and student achievement. By enrolling in this program, your PTA and school administrators are making a year-long commitment in identifying and implementing an action plan for school improvement based on PTA's National Standards for Family-School Partnerships and the Four 'I's of Family Engagement.

The School of Excellence Program aims to:

- Provide a framework for PTAs to identify and implement best practices in family engagement to strengthen family-school partnerships
- Build inclusive and welcoming school communities where all families contribute to enriching the educational experience and overall well-being for all students

- Help PTAs attract new, action-oriented PTA members who want to focus on the issues that affect our children the most
- Provide step-by-step guidance and networking opportunities for PTAs to gain support and feedback, identify and reach goals and earn recognition
- Celebrate designees and top Phoebe Apperson Hearst awardees as national leaders in building effective family-school partnerships, which opens additional honors and opportunities

## Established 2014

## Sponsor

PTA's National Standards for Family-School Partnerships

## Size

1,216

## Criteria

**1. Enroll and Gain Support**

- The first step is to enroll and gain support from your school administrators. You will then build an Excellence Team, a group of diverse members who will work with you throughout the program to improve family-school partnerships at your school. Immediately upon enrolling, you will gain access to our online toolkit with resources like our Program Leader's Guide and trainings to help you complete the program and reach your goals.

**2. Deploy Baseline Survey School Community**

- You and your Excellence Team will deploy National PTA's Baseline Survey questions to your school community – including families, administrators, and staff to gauge perceptions of current family-school partnership trends at your school.

**3. Use Results and Tools to Take Action**

- Once you submit the results to National PTA, we will provide you with a Roadmap to Excellence to give you recommendations and resources to help you reach your goals. With this information and through discussions with your Excellence Team and administration, you will prioritize ways that your PTA can better engage families throughout the year. Then, you'll work to create and implement action toward school improvement with National PTA with you every step of the way, providing information and encouragement.

**4. Survey School Community Again**

- Towards the end of the school year, you will conduct a Final Survey to evaluate your progress over the school year, once again gathering feedback from your school community and analyzing the results. By June 1, you will submit the results as well as a supporting narrative describing how you have strengthened family engagement throughout the school year.

## Award Categories

National PTA School of Excellence for two years.

## Cost

No Cost

## Eligibility

The school must be a PTA school to participate in the program and must be in good standing, according to the state PTA.

## Application Process

- **Step 1:** Enroll and Gain Support (June 1 –Oct. 15 - deadline extended from Oct. 1)
- **Step 2:** Deploy Baseline Survey (Sep. –Nov.)
- **Step 3:** Set a Shared Objective (Sep. –Nov.)
- **Step 4:** Complete Initial Application (Submit by Nov. 15 - deadline extended from Nov. 1)
- **Step 5:** Follow Roadmap to Excellence (Throughout School Year)
- **Step 6:** Deploy Final Survey (March –June)
- **Step 7:** Complete Final Application (Submit by June 1)
- **Step 8:** Celebrate Your Excellence (Aug.)

## Method of Recognition or Designation

National PTA Schools of Excellence and will receive a banner, certificate, and online celebration toolkit to help you host celebration events and promote this incredible honor.

## Benefits to the Recipient Institutions

According to the PTA School of Excellence designation will help attract new, action-oriented PTA members who want to focus on the issues that affect our children the most. Being a National PTA School of Excellence will open the door to other honors and opportunities for your school. You will receive a National PTA School of Excellence banner to hang prominently at your school, which will tell families right away–you are welcome here and you are important to our student's success! You will also receive a Celebration Kit, containing event-planning and media outreach templates and tools.

National PTA will include your PTA and school in our national program promotion, specifically showcasing how your school and PTA are leading the nation in your approach to family-school partnerships. In addition, as a National PTA School of Excellence, you will automatically be considered for National PTA's highest honor–the Phoebe Apperson Hearst Family-School Partnership Award (PTA.org).

### Perception of the Program

Testimonials:

> *"This was my first time leading the program and I found it to be a great way to set a concrete goal for our PTA and help us achieve it with an easy, step-by-step action plan. Emails, reminders, webinars—all the materials provided were accessible and easy to understand. This is a user-friendly program that can lead PTAs to greater success, even when they are already high-achieving PTAs. We are always looking to improve and reach our families in as many ways as possible." –Meredith Loudenback, Chets Creek Elementary PTA, Florida*

> *"Bringing together administration, teachers and ALL parents together for the betterment of our school takes what we do to another level. It was more than just building relationships with our parents; it was about reaching all parents in a way that we have not done in the past. Having the data on how we can engage parents more, and then setting action steps on the findings provides all parents the welcoming environment and comfort they deserve to feel when stepping into our school." –Lisa Carlson, Barksdale Elementary PTA, Texas*

> *"Participating in the PTA School of Excellence program was a valuable experience for the Leadership Team at Sope Creek Elementary School. The surveys provided us the unique opportunity to look at our school community from a different perspective. The data from the PTA School of Excellence program is vitally important and has helped us shape our vision toward excellence and continued success." –Douglas Cox, Sope Creek Elementary PTA, Georgia*

## AMAZON FUTURE ENGINEER

### Program Overview

Amazon Future Engineer is a four-part, childhood-to-career program aimed at inspiring and educating hundreds of thousands of students from underrepresented and underserved communities each year to try computer science and coding.

Elementary (K-5): Amazon Future Engineer sponsors district-wide onsite professional development to elementary school teachers for computer science education. The sponsorship provides everything districts across the US need to implement a sustainable computer science initiative. In addition, our robotics grant program provides more than 150 schools with FIRST memberships, more funding for computer science, and access to tours of Amazon Robotics fulfillment centers. We are particularly focused on making sure more students from underrepresented and underserved communities give computer science a try because research shows they are far more likely to pursue computer science later into their academic career if they can have this early exposure.

Middle & High School: Amazon Future Engineer currently provides more than 2,000 schools that serve students from underrepresented and underserved communities across the country with Intro to Computer Science and AP Computer Science classes. On June 30th, 2020, we launched a way for any teacher at an underserved

Middle or High School to join to receive Amazon's sponsorship of preparatory lessons, professional development for teachers, fully sequenced and paced digital curriculum for students. Our two providers are Code.org (Middle & High School) and Edhesive (High School only). The full-year courses are designed to inspire, prepare, and propel students in their pursuit of a computer science education.

All educators and students participating in this program are eligible for the annual $25,000 Amazon Future Engineer Teacher of the Year Award. They have access to a no-cost membership with AWS Educate, Amazon's global initiative to provide students comprehensive resources for building skills in cloud technology. They also receive teaching supports such as membership to professional community and an inspiration kit to assist in student recruitment.

### Scholarship

Each year, Amazon Future Engineer provides 100 students from underrepresented and underserved communities planning to study computer science at a four-year college or university with $10,000/year scholarships.

### Internship

Each year, Amazon Future Engineer offers the 100 scholarship recipients a guaranteed, paid internship at Amazon after their first year of college. Interns partner with a technical mentor and manager, as well as other interns, to innovate and create new features and services on behalf of Amazon customers.

### Purpose/Goal

Amazon is committed to helping more students, especially students from underrepresented and underserved communities, have the resources and skills they need to build their best futures. Amazon is known for its long-term thinking style, and we know that coding is the language of the future. Additionally, STEM education and computer science are ingrained into the work many Amazon employees rely on day in and day out.

### Established 2018

### Sponsor

Amazon

### Size

Amazon Future Engineer is a big part of Amazon's $50 million investment in computer science over the next five years. Amazon Future Engineer has also donated more than $20 million to organizations that promote computer science/STEM education across the country. Amazon Future Engineer funds Introductory and Advanced Placement computer science courses in more than 2,000 high schools serving more than 100,000 students in underserved and underrepresented communities.

### Cost

No cost

## Eligibility

**Amazon Future Engineer + BootUp Elementary Computer Science Initiative**

The Amazon Future Engineer sponsorship provides three years of ongoing onsite professional development to elementary teachers on the content and pedagogy of computer science education. The sponsorship provides everything districts need to implement a sustainable computer science initiative. This includes eight onsite professional development workshops, ongoing model teaching and coaching, curricula and teacher lesson plans, and an online Instructional Coach Course to ensure the sustainability of the program.

U.S. public school districts serving elementary students are eligible to apply for this opportunity. Applications will not be accepted from individual schools or teachers but must be authorized and submitted through their District or LEA. The District's superintendent (or approved designee) signature is required through a Superintendent Recommendation form. District support is a critical component in the successful implementation of this initiative.

**The Amazon Future Engineer Program**

The Amazon Future Engineer program for Middle and High Schools is offered to schools in the USA with:

- Title 1 status OR
- Enrollment of more than 40% students from marginalized racial and ethnic groups underrepresented in computer science*
- Enrollment of more than 40% students who qualify for free or reduced lunch

## Application Process

Must meet eligibility requirements and then can apply on https://www.amazonfutureengineer.com/

## Method of Recognition or Designation

All Amazon Future Engineer teachers can apply to the Amazon Future Engineer Teacher of the Year Awards starting on February 13th through March 12th at AmazonFutureEngineer.com. School principals, administrators, peers, and students can also nominate Amazon Future Engineer teachers, encouraging them to apply. Amazon will notify award recipients later this year. The schools of award recipients will each receive a prize package valued at over $25,000, which may include a variety of needed donations to their classrooms, STEM toys and activities, school upgrades and enhancements and more. They will also receive an all-expenses paid trip to re:MARS, Amazon's AI event covering a diverse array of topics and themes related to Machine Learning, Automation, Robotics, and Space. Teachers with questions about the Awards can visit AmazonFutureEngineer.com.

## Benefits to the Recipient Institutions

**Elementary Schools**

- The Amazon Future Engineer sponsorship provides three years of ongoing onsite professional development to elementary teachers on the content and pedagogy of computer science education. The sponsorship provides everything districts need to implement a sustainable computer science initiative. This includes eight onsite professional development workshops, ongoing model teaching and coaching, curricula and teacher lesson plans, and an online Instructional Coach Course to ensure the sustainability of the program.

- Districts who are awarded will participate in professional development over a three-year period and teach computer science to students during the school day. Every district is different; professional development and support will be customized and scheduled to consider each district's unique needs. Professional development and support will take place onsite at your district.
- This application is for a service award (no money is awarded) that provides all the support needed to implement computer science in elementary grades district wide. All professional development, support, and curriculum will be provided to each district at no cost. Districts will receive BootUp's free project-based curriculum which uses the free coding platforms Scratch and ScratchJr. The curriculum (and over 100 projects) will remain free and available beyond the life of the award.

**Middle and High Schools**

- Free curriculum options from multiple providers including Code.org, ProjectSTEM, and CMU CS Academy
- Free Asynchronous Online Training
- Live Online Training
- In-Person Training
- Paid CSTA Plus Level Membership
- Eligible for $30,000 teacher of the year award
- Posters and recruiting materials
- Priority booking for Career Talks with Amazon Professionals
- Priority registration for free classroom tours of Amazon's Fulfillment Centers

## MICROSOFT SHOWCASE SCHOOLS

### Program Overview

Building on our decades of work with policy makers, school leaders and educators around the world, Microsoft supports Schools in the Showcase School program with resources and ideas turn their vision into reality.

Showcase Schools create student-centered, immersive, and inclusive experiences that inspire lifelong learning, stimulating development of essential future-ready skills so students are empowered to achieve more.

### Purpose/Goal

The Microsoft Showcase Schools Program is an opportunity to engage with Microsoft and like-minded school leaders around the world to deepen and expand education transformation using the Education Transformation Framework. The Microsoft Education Transformation Framework is a guide for education leaders to navigate the complexity of transformation impacting every aspect of their mission. It facilitates the process of envisioning what's possible and developing a strategy to achieve it.

### Established 2014

### Size

Schools in North America, Europe, South America, Africa, Asia, Oceania. Approximately 40 schools in the United States.

### Cost

None

### Eligibility

Any school that works through the application process.

### Application Process

- Familiarize yourself with the Microsoft K-12 Education Transformation Framework
- Review the Showcase School rubric to identify where your school is on the transformation journey and the areas in which you'd like your school to grow
- Learn about the Showcase School Program engagement process
- Fill out a self-nomination for your school

### Method of Recognition or Designation

Listed in the Microsoft Showcase Schools Directory, promote on school site and literature.

### Benefits to the Recipient Institutions

- Share insights, best practices, and engage in local or global Microsoft events
- Enjoy Microsoft partner offers and product support, digital transformation guidance and access to resources and latest research
- Help shape the future of Microsoft education products and programs, contribute to the vision of schools and students around the world, and elevate your school's visibility and role as a leader

## GREEN RIBBON SCHOOLS RECOGNITION PROGRAM

### Program Overview

The award program enables a small number of honorees each year to communicate practices and resources that all schools can employ. To this end, ED-GRS launched Green Strides, an effort to connect all schools with the resources these honorees are using in the three 'Pillars' of the award.

### Purpose/Goal

The purpose of the U.S. Department of Education Green Ribbon Schools (ED-GRS) is to inspire schools, districts, and institutions of higher education (IHEs) to strive for 21st-century excellence by highlighting promising

school sustainability practices and resources that all can employ. To that end, the award recognizes schools, districts, and IHEs that:

1. Reduce environmental impact and costs
2. Improve the health and wellness of schools, students, and staff
3. Provide effective environmental and sustainability education

Combined progress in ALL three of these areas, known as Pillars, serves as the basis for recognition.

## Established

In the Summer of 2011, the NGO criteria was developed. The program was developed in partnership with Campaign for Environmental Literacy, the Earth Day Network, the National Wildlife Federation and the U.S. Green Building Council.

## Size

Despite the exciting efforts ED has highlighted with this recognition award, there is still work to be done to improve school facilities, health, and environmental engagement. Typically, approximately 30 states voluntarily nominate candidates annually for this award. That means that ED does not have a mechanism for highlighting the practices of green schools in the remaining 20 or so states where state educational agencies choose not to nominate.

*Table 1. Number of U.S. Department of Education Green Ribbon School honorees by year and type**

| Year | Schools | Districts* | Postsecondary* | Total |
|---|---|---|---|---|
| 2012 | 78 | N/A | N/A | 78 |
| 2013 | 64 | 14 | N/A | 78 |
| 2014 | 48 | 9 | N/A | 57 |
| 2015 | 58 | 9 | 14 | 81 |
| 2016 | 47 | 15 | 11 | 73 |
| 2017 | 45 | 9 | 9 | 63 |
| 2018 | 45 | 6 | 6 | 57 |
| 2019 | 35 | 14 | 4 | 53 |
| 2020 | 39 | 11 | 5 | 55 |
| 2021 | 30 | 5 | 5 | 40 |
| **Total** | **489** | **92** | **54** | **635** |

*The District Sustainability Award was added in 2013 and the Postsecondary Award in 2015.

## Criteria

State education authorities, including both CSSOs and SHEEOs, working with governor's offices, higher education officials, and other partners, as appropriate in each state, must submit documentation of school, district, and postsecondary nominees' progress under the Pillars and Elements, listed below. They are encouraged to reference a variety of widely accepted sustainability standards, certifications, ratings, and programs. Nominating authorities, district officials, and principals (where applicable) must certify compliance with all applicable civil rights, student aid, health, environment, and safety statutory and regulatory requirements.

Nominating authorities are encouraged to engage state health, environmental, and safety authorities; nonprofit experts in these areas; and federal agency field offices with appropriate technical expertise. In addition to providing valuable subject matter expertise, these partners can make the task of recruiting applicants and selecting nominees to the Department less cumbersome.

**ED-Green Ribbon Schools Pillars and Elements**

1. **Reduced Environmental Impact and Costs**
   a. Reduced or eliminated greenhouse gas emissions, using an energy audit or emissions inventory and reduction plan, cost-effective energy efficiency improvements, conservation measures, and/or on-site renewable energy and/or purchase of green power
   b. Improved water quality, efficiency, and conservation
   c. Reduced solid and hazardous waste production through increased recycling and composting, reduced consumption, and improved management, reduction, or elimination of hazardous waste
   d. Expanded use of alternative transportation, through active promotion of locally available, energy-efficient options and implementation of alternative transportation supportive projects and policies

2. **Improved Health and Wellness**
   a. High standards of Whole School Whole Community, Whole Child health, including health, nutrition, and outdoor physical education; health, counseling, and psychological services for both students and staff; family community involvement
   b. An integrated school environmental health program that considers occupant health and safety in all design, construction, renovation, operations, and maintenance of facilities and grounds, including cleaning and maintenance; mold and moisture; chemical and environmental contaminants; ventilation; and pests and pesticide

3. **Effective Environmental and Sustainability Education**
   a. Interdisciplinary learning about the key relationships between dynamic environmental, energy, and human systems
   b. Use of the environment and sustainability to develop STEM content knowledge and thinking skills to prepare graduates for the 21st-century technology-driven economy
   c. Development of civic engagement knowledge and skills and students' application of such knowledge and skills to address sustainability issues in their community

## Award Categories

Each authority is invited to nominate up to five schools or school districts and a single IHE that it assesses to be the highest performing in their jurisdiction, based on the authorities' evaluation of applicants' progress in all Pillars and every Element.

Authorities should consider demographic and geographic diversity and success in closing achievement gaps in their selections. ED will do the same in the federal review, aiming for a diverse cohort, representative of the full spectrum of schools, school districts, and IHEs across the nation.

## Cost

None

This award conveys no ED funding to states, districts, schools, or IHEs. ED has limited authorities in the areas of school facilities and grounds, health, and curriculum. Most policies and practices in these areas fall within the purview of state and local education authorities. Thus, this school sustainability initiative is a well-intended federal communications and outreach tool structured as a recognition award. It is not a certification or tracking program, though some states may choose to connect it to existing state-based certification programs.

## Eligibility

State education authorities, including both CSSOs and SHEEOs, working with governor's offices, higher education officials, and other partners, as appropriate in each state, must submit documentation of school, district, and postsecondary nominees' progress under the Pillars and Elements, listed below. Participating states have considerable autonomy on how they select their nominees to ED. For postsecondary nominees, state selection committees may include input from the governor's office, postsecondary offices, and/or associations of higher education, as appropriate.

They are encouraged to reference a variety of widely accepted sustainability standards, certifications, ratings, and programs. Nominating authorities, district officials, and principals (where applicable) must certify compliance with all applicable civil rights, student aid, health, environment, and safety statutory and regulatory requirements.

Nominating authorities are encouraged to engage state health, environmental, and safety authorities; nonprofit experts in these areas; and federal agency field offices with appropriate technical expertise. In addition to providing valuable subject matter expertise, these partners can make the task of recruiting applicants and selecting nominees to the Department less cumbersome.

## Application Process

Schools, districts, and postsecondary institutions do not apply to ED for this award, but to their state education authorities, whether K-12 or postsecondary. State participation in the award is voluntary and not all state education authorities choose to nominate.

Many states use an application to select nominees, but do not have to offer a distinct application for this award. They may already know of good candidates and work with them to document their achievements. In other cases, states already have programs that ask that schools document their sustainability work and re-purpose those program applications for this nomination. In addition, ED offers an example application format to states.

States submit their nominees to ED by February 1. They set their own state-specific application deadlines to allow them time to review and select nominees. ED announces national honorees in spring. States are encouraged to offer additional state recognition titles and events, and to partner with the private sector to offer cash prizes, amplifying the impact of their award implementation.

### Method of Recognition or Designation

Honored schools, school districts, and IHEs are announced each spring. The selectees are invited to a fall ceremony in Washington, D.C. where they receive a sustainable plaque; are the subject of media attention; and feel their efforts celebrated. Other schools, in turn, learn about and adopt their practices. States are encouraged to offer additional state recognition titles and events, and to partner with the private sector to offer cash prizes, amplifying the impact of their award implementation.

Annual Highlights Reports detail honorees' replicable practices. Social media and newsletters share resources and practices in the areas of school facilities, health, and environment. An annual Green Strides Tour brings further attention to the honorees and their practices.

### Benefits to the Recipient Institutions

A key benefit of the award is helping to facilitate state and local collaboration around school facilities, health, and environmental education. States are asked to show ED how their nominees are progressing in all three Pillars and encouraged to work with partners to develop their selection process. How each state does that is entirely up to the individual state. There is no required federal application.

### Takeaways

- Good program to advance the three criteria or goals of the program on a nation-wide scope.

## PURPLE STAR CAMPUS DESIGNATION PROGRAM

### Program Overview

A Purple Star School is a public or charter school that has committed to supporting the unique educational and social-emotional needs of military-connected children.

A designated point-of-contact for military-connected families,

Staff professional development on serving military-connected students and families,

A dedicated website with information relevant to military-connected families,

A new student transition program, and

Military recognition events.

## Purpose/Goal

The Purple Star program seeks to reduce this burden on families. By articulating the most critical transition support for military-connected families and publicly designating schools that meet those requirements, the program signals to military-connected families which schools are the most committed and best equipped to meet their needs. The program addresses the following major academic challenges faced by military families:

- Variations in state curricula and standards mean that highly mobile students often experience gaps and overlaps in academic content as they transfer between states. This results in a knowledge gap relative to their peers and may cause feelings of confusion and inadequacy that interfere with the academic and skill development of the students. On the other hand, when content is repeated, students may lose the opportunity to advance or may simply become bored and detached. These content misalignments can also cause mobile students to miss prerequisite classes for desired tracks in advanced or specialized coursework. Finally, repeated transfers often compound these learning gaps, affecting students' achievement and habits in the classroom (Center for Public Research and Leadership, 2017).

- As part of the transition, students transfer academic credits between institutions. However, when credits are not properly interpreted by the new school or communicated by the old school, or simply do not align with the requirements of the new school, the student can face a deeply troublesome mismatch. Students may find themselves repeating courses, losing credits, dropping class rank, and or struggling to keep up in classes. High school students may be affected most by this problem. Since states have varying credit requirements for graduation, students who move later in their high school years may face significant challenges meeting the new school or state requirements and find themselves cramming extra classes into their schedules or graduating late because of resulting credit deficiencies (Weisman, 2012).

- Differences in enrollment practices, academic calendars, schedules, and program admissions further complicate academic transitions. Schools across the country start and end at different times of the year, and transferring students sometimes miss weeks of school because of these unexpected calendar differences. Mobile students may also miss application deadlines or testing requirements for special programs.

## Established 2017

## Sponsor

The Purple Star program is a ground-up initiative with no central governing body. Military Child Education Coalition® (MCEC) - Established in 1998, the Military Child Education Coalition (MCEC) is a nonprofit organization that solely exists to help the military-connected child and youth thrive. MCEC supports all military-connected children by educating, advocating, and collaborating to resolve education challenges associated with the military lifestyle.

## Size

To date, there are only nine states with Purple Star School programs. The Purple Star program was designed to help mitigate the challenges of high mobility by setting standards for and publicly designating military-friendly schools. Launched as a grassroots initiative in Ohio in 2017, there are now active or developing Purple Star initiatives in 11 states: Arkansas, Georgia,1 Indiana, Montana, New Hampshire, North Carolina, Ohio, South Carolina, Tennessee, Texas, and Virginia.

## Criteria

1. Designate a campus-based military liaison that must:
   a. Support military connected students and their families
   b. Offer professional development opportunities for staff members on issues related to military-connected students

2. Create and maintain an easily accessible web page that includes information for military-connected students and their families.

3. Must have a campus transition program that includes:
   a. Introductions to school environment and processes
   b. Student leaders or ambassadors should be support or sponsored by a campus-based staff member
   c. Participate in organizing and hosting newcomer social events, facilitating guided tours of the campus, and accompanying new students to lunch the first week of school

4. Offer at least one of the following initiatives:
   a. A resolution showing support for military-connected students and families
   b. Participation in Month of the Military Child or Military Family Month
   c. Partnership with a school liaison officer to encourage and provide opportunities for active-duty military members.

## Award Categories

1. Purple star: 500 feedback points.
2. Red star: 1,000 feedback points.
3. Green star: 5,000 feedback points.
4. Yellow shooting star: 10,000 feedback points.

## Cost

State Funded.

## Eligibility

Overwhelmingly, schools and districts report that the process of applying for the Purple Star designation and maintaining Purple Star programming has not represented a significant administrative challenge. When asked about the difficulty of establishing programming in their schools, 86 percent of school-level survey respondents report that the process was either “very easy,” “easy,” or “neither difficult nor easy” (see Figure 2). Similarly,

96 percent of respondents note that maintaining the designation once awarded has been “very easy,” “easy,” or “neither difficult nor easy” (see Figure 3).

Figure 2. How challenging was it to establish the Purple Star program at your school?

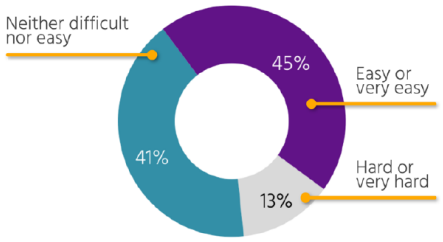
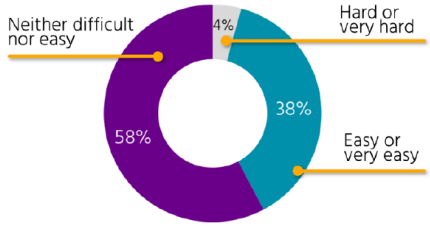
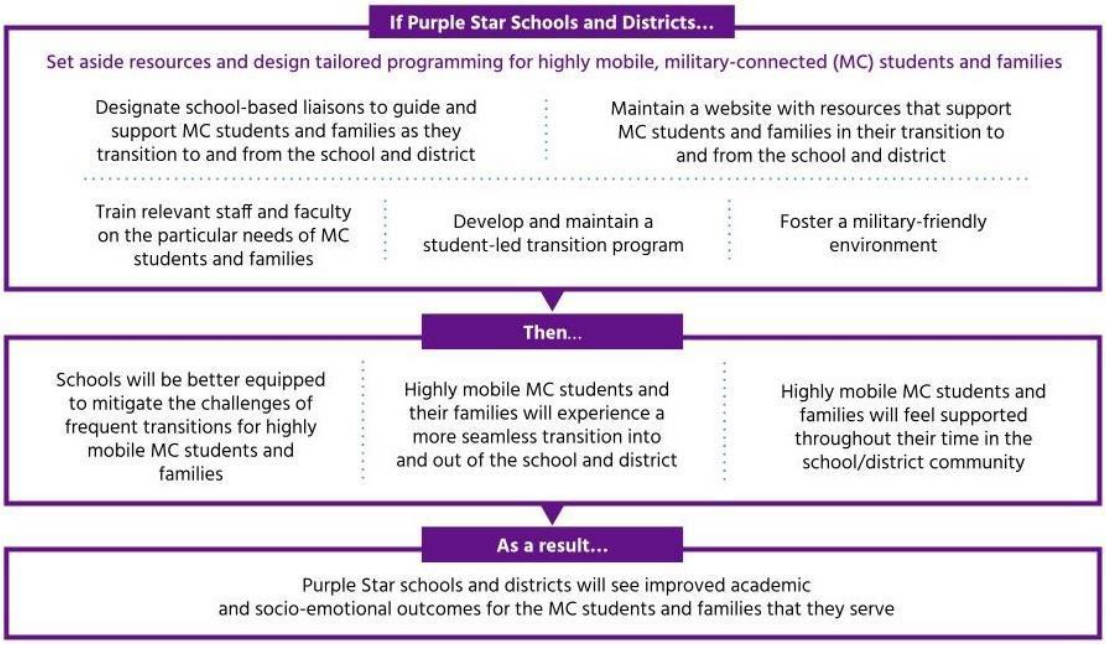



Figure 3. How challenging has it been to maintain the Purple Star program at your school?




Data from state-level Purple Star leaders show that the process of creating and implementing the initiative has become easier with each new state. Ohio, the founding program, did much of the heavy lifting by bringing together stakeholders from different military branches and schools to formulate the basic requirements we now see in most iterations of the program. Our interview data suggest that, for many states, the design of the subsequent states’ programs required only minor tweaks to these core requirements and implementation plans, though most states did still opt to draw on the input of local stakeholders to appropriately contextualize the program design. One state actor emphasized that this had eased the development process because their state did not have to “reinvent the wheel.”

State leaders did note some minor roadblocks to implementation. Several state program leaders talked about the difficulty of tailoring the requirements so that schools with varying levels of resources have an equal opportunity to earn the designation. And one state emphasized weighing the benefits and limitations of using a formal legislative process or informal state DOE action to establish the program. Overall, however, states emphasized that roadblocks to the programs were minor and the benefits the program provided to schools and military-connected families were unequivocal.




## Application Process

The application period for the 2020-2021 school year opened on Wednesday June 10, 2020, and will close on Friday, August 28, 2020.

1. The campus-based military liaison must complete the Texas Education Agency (TEA) Purple Star Campus Designation application available on the TEA website.
2. Campus designation criteria must be met and submitted in the application.
3. The Purple Star Campus Designation will be awarded every school year beginning with the 2020-2021 school year.
4. Campuses that satisfy the criteria and are awarded the Purple Star Campus Designation are eligible to recertify the designation every two school years.
5. Campuses not selected for award of the Purple Star Campus Designation will be given an opportunity to appeal the decision of non-selection through an appeal process explained in the non-selection notification.

## Method of Recognition or Designation

The Purple Star program is a ground-up initiative with no central governing body. As such, each state — or other granting body, such as a district — may use their discretion to enact, design, and administer its own iteration of the program. Accordingly, there is some variation nationally in how programs are executed and in the criteria schools must meet to become Purple Star-designated. Still, a number of shared, research-driven components have come to define the designation at the national level.

- Schools should appoint a staff member to act as a liaison between military families and the school, easing military-connected students' enrollment and acclimation period.
- Schools should train staff on the unique considerations for and needs of military-connected students.
- Schools should develop a dedicated page on the school or district website with easily accessible information and resources for military-connected families.
- Schools should implement a transition program to welcome and socially acclimate incoming military-connected students. Some, but not all states, require that this program be student-led.
- Schools should host programming and events to celebrate and honor service members and military-connected students, families, and community members.

## Perception

The Purple Star program has already gained traction and motivated hundreds of schools and scores of districts to improve services for military-connected (MC) students and families. This is especially notable given that the program has been in place for less than three years in most states, with a third of that time overlapping the COVID-19 health crisis.

The Purple Star program's true value derives from its potential to:

- Centralize and make knowledge accessible,
- Develop stakeholder networks, and
- Support schools in cultivating and communicating cultural competency in supporting military-connected families.

Most Purple Star schools and districts already had programming for military-families in place before seeking designation. Still, staff and faculty report that they have benefited from the Purple Star application process and the encouragement to refine and expand programming related to the program designation requirements. of the Program:

Of the core designation requirements, selecting a point-of-contact, training more staff and faculty, and establishing new student transition programs are commonly cited as the highest-impact activities.
Designing an accessible and relevant dedicated webpage is still a need for many schools.
Schools and districts appreciate and benefit from the recognition and publicity the designation offers, but brand recognition for the program among families is still fairly low.

# Part II: Key Program Takeaways and Drawbacks

## NATIONAL BLUE RIBBON SCHOOLS PROGRAM

### Key Takeaways

- National Program (some states elect not participate in this program)
- Sponsored by department of education
- This gets a lot of political promotion, recognition, and publicity
- Look upon highly by administrators
- Exclusive designation

### Program Drawbacks

- Very few schools qualify
- Awarded Based on academic test scores
- Equity and Diversity
- Does not deal with addressing workforce needs only focused on testing scores
- The number of awardees in the state do not reflect the state's population and number of schools
- It has a perception of elitism

## BLUE RIBBON SCHOOLS PROGRAM OF EXCELLENCE

### Key Takeaways

- The program was developed to assist schools that would have a difficult time earning a national award
- It is based on a academic maturity model
- They provide resources and expertise to approve under performing schools
- They have a smart marketing approach by having the conference held at Disney World every year
- There is no limit to the number of schools
- It is a multi-tiered award program
- All schools must complete an application
- Nomination Process
- Has a broad eligibility criteria

### Program Drawbacks

- The schools must pay a fee
- It has created confusion between this program and the National Blue Ribbon Program
- This has resulted in revelry in the designation programs
- Ran by an independent program that has no oversight

## GOVERNOR'S DESIGNATED STEM SCHOOLS (MULTIPLE STATES) PLATINUM SCHOOLS

### Key Takeaways

- Decentralized and State led
- State funded and involves schools in diverse locations
- School readily adopt state funded initiatives
- Gained a lot of support from state governs
- Very well designed and implemented
- The frameworks are based on direct feedback with businesses
- Focused on STEM related jobs and workforce needs of the state implemented
- Schools must redesignate

### Program Drawbacks

- School must be a STEM school with the available resources to apply
- It is depended on governor backing then if there is a new administration it could affect funding
- This is a local program and not a national program
- Requires more industry and business engagement

## NATIONAL CERTIFICATIONS FOR ROBOTICS AND ADVANCED AUTOMATION MANUFACTURING

### Key Takeaways

- The designation program is a partnership with industry
- Large program but not necessarily covering the US
- Focused on workforce needs and less on academic requirements.
- Schools are active in identifying eligibility measures
- Designation is based on employability competencies
- Students that graduate from this are valued by local employers

### Program Drawbacks

- Designation Cost
- Single vender support
- Specific equipment
- Employee Subject Matter Experts
- Driven more by industry needs than academic

## SOUTHERN REGIONAL EDUCATION BOARD'S (SREB) HIGH SCHOOLS THAT WORK (HSTW)

### Key Takeaways

- This is a regional program
- Ran by leadership at the state level
- It focuses on both policy and practices
- Been around for a long time
- Tiered program and provides mentorships and other resources to schools
- Based on a continuous improvement model

### Program Drawbacks

- Very rigorous program with lots of criteria
- Based on a maturity model
- Focus in not on workforce needs

## PROJECT LEAD THE WAY (PLTW) DISTINGUISHED SCHOOLS

### Key Takeaways

- Several different awards categories with specifics criteria, including a district award. Separate K-5, 6-8, 9-12
- Focus on activity, project and problem-based instruction to complete hands-on real-world activities and projects.
- Curriculum and resources provided
- Promotional and support benefits
- No limit to number of schools
- Low barrier to entry
- Recognitions factor strategies and/or procedures in place to support reasonably proportional representation with regard to race, ethnicity, poverty, gender, etc.
- One year designation that must be renewed yearly
- National Program with strong community practice
- Positive program perception
- Do have cybersecurity curriculum

### Program Drawbacks

- Cost may be prohibitive
- Awards are based on percentage of students participating–not performance
- Based on PLTW curriculum
- Run by private non-profit organization

## LEAGUE OF INNOVATIVE SCHOOLS – DIGITAL PROMISE PROGRAM

### Key Takeaways

- The main purpose if to
- It is a multi-category of awards
- Multiple areas for award criteria in non-academic
- Open to any schools
- Is currently in 34 states
- Has received good publicity
- Has a community of practice

### Program Drawbacks

- Not a workforce focused designation
- Requires publishing materials to be designated

## National Academy Foundation (NAF) Future Ready Schools

### Key Takeaways

- Created to be modular, fits inside an existing high school systems with support
- A year of planning model and a fast-track model for those qualified
- US Department of Education's 16 career clusters including IT and STEM
- Focuses on workforce readiness
- Curriculum and resources provided
- Benefits of promotion, support, awards, scholarships
- 40-year history
- Encourages dual credit, early college partnership
- National–in 34 states

### Program Drawbacks

- May be cost prohibitive
- Locked into specific NAF requirements
- Selectively accepting new partners currently
- Membership not a designation program

## CALIFORNIA DISTINGUISHED SCHOOLS PROGRAM

### Key Takeaways

- There are many sponsored to the program
- No cost to the program
- Have been around for 35 years
- Local State program
- Requires redesignation

### Program Drawbacks

- This is a CA state program only
- Focused on academics and not job readiness
- Has negative perception and some of it dealt with equity and including for diverse schools

## U.S. PRESIDENTIAL SCHOLARS IN CAREER AND TECHNICAL EDUCATION PROGRAM

### Key Takeaways

- Department of education award
- Have been around since the 1960
- This award is given directly to students
- Specific awards for Career and Technical education
- Controlled at a State level
- No cost
- Bring a lot of recognition to the schools

### Program Drawbacks

- Popularity is based on state support
- Student designation not an institutional designation

## CTE CYBERNET SCHOOLS US DEPARTMENT OF EDUCATION

### Key Takeaways

- Department of Education initiative
- Based around cybersecurity program development
- Includes faculty development and ongoing mentoring
- Provides resources to participating schools
- Direct partnerships with CAE institutions
- Operated by Luminary labs contracted with the Department of Education
- Corporate sponsorship

### Program Drawbacks

- Limited to 30 schools
- More of a membership program than a designation program
- There is no renew membership
- There is no cost, but it is funded by the Department of Education

## NATIONAL PTA SCHOOL OF EXCELLENCE

### Key Takeaways

- More focused on overall school academics
- Designed to promote parent involvement
- No cost - just membership as a PTA school
- Award or designation program 2-year designation
- Started in 2014
- Promote family and school partnership
- National program 1200 schools
- Recognized by many governors and state department of education

### Program Drawbacks

- Not focus of career of workforce needs
- Receive a banner and other ways to promote the designation
- Requires all schools to have an established Parent Teacher Association

# AMAZON FUTURE ENGINEER

## Key Takeaways

- Programs broken out by Elementary vs Middle and High School
- Designed to help schools in need (Title 1 status)
- Curriculum and resources provided'
- Significant Instructor Professional Development
- Focus on Computer Science and Coding
- Monetary benefits for performance
- No Cost to schools
- Annual scholarships of $10,000 for 100 students per year
- Operates in five countries- Canada, France, Germany, India, UK, US
- More than 2,000 high schools serving more than 100,000 students in underserved and underrepresented communities.
- 100 scholarship recipients a guaranteed, paid internship at Amazon after their first year of college.
- Title 1 status OR
- Enrollment of more than 40% students from marginalized racial and ethnic groups underrepresented in computer science*
- Enrollment of more than 40% students who qualify for free or reduced lunch
- All educators and students participating in this program are eligible for the annual $25,000 Amazon Future Engineer Teacher of the Year Award.

## Program Drawbacks

- Must be a title one school or
- Schools able to apply are limited
- Established 2018–relatively new program
- More of a membership

## MICROSOFT SHOWCASE SCHOOLS

### Key Takeaways

- Global Program
- More of a recognition program for those that demonstrate they are meeting Microsoft's K-12 Framework.
- Requires schools to adhere to educational best practices
- Has a detailed, formal rubric making the application process transparent to schools
- Community of showcase schools to learn from, and adopt new teaching methodologies
- No limit on the number of schools

### Program Drawbacks

- No comprehensive curriculum provided to assist schools
- Limited number of schools current are Showcase schools–approximately 40 in the US
- 8-year history- fairly new

## GREEN RIBBON SCHOOLS RECOGNITION PROGRAM

### Key Takeaways

- Good program to advance the three criteria or goals of the program on a nation-wide scope.
- Inspire school districts to promote sustainability and green initiatives
- Criteria
- Sponsored by non-profit organization supported by the US department of education.
- Institutional award
- Application process–only can apply if state's authority nominates
- 635 schools
- Invited to DC for recognition and included annual published report

### Program Drawbacks

- Some states don't participate
- One time award–no redesignation

# PURPLE STAR CAMPUS DESIGNATION PROGRAM

## Key Takeaways

- Encouraging schools to help veterans and their family members
- Offering veterans opportunities to complete GED, high school
- Helping special services for families of those serving
- Run at the state level
- Run by non-profit organization
- Criteria designed to support families
- Points system based on five criteria which you must document experience in each area
- Must have a campus transition program to help military personnel transitioning back to civilian life
- No cost to schools
- Application process

## Program Drawbacks

- Not an academic award program or work readiness program
- In limited number of states
- Based in states with many military families

# Part III: Study Conclusions

## Finding One

### The program sponsors established and operated the programs to meet their specific mission, goals, and objectives.

Each of the organizations and programs our team studied were organized based on the mission, goals, and objectives of the program. However, the mission, goals and objectives varied greatly.

Some of the organizations were establish to very specifically recognized excellence. This could include academic excellence measured by overall standardized testing scores or other measure of student and program performance. Other organizations had a broader mission like workforce development, establishment of a continuous improvement process or adoptions and demonstration of best practices set forth by the designation sponsoring organization.

Our finding is that the designation or recognition program established should start by having the steering committee identify the mission, goals, and objectives of the program.

## Finding Two

### The program sponsors have defined clear cut benefits of receiving the designation or recognition.

Most of the programs examined identify very clear benefits of the designation or recognition. The following is a summary of program benefits:

- Mentorship
- Institutional engagement in continuous improvement
- Membership in a community of practice
- School, administration, faculty, and local community recognition
- Promotion of specific programs
- Recognition of student performance
- Financial resources
- Curriculum and or faculty development

## Finding Three

### The program nomination and application process must be clearly promoted and meet the scope and purpose of the program.

The nomination and application process differ greatly between the different programs. Some programs limit the nomination to just a few schools per state while others have unlimited number of nominations. Some nominations are handled nationally while other nominations are distributed to state education organizations for the nomination and application review process. The nomination and application process will ultimately control the growth and size of the programs. A national versus local control of the nomination and application process impacts the level of local support, ownership, control over criteria, ability to tap local funding and perception of the programs. The high school community is exponentially larger than the post-secondary community. The support of state agencies, governors and local academic organizations is critical for reaching a scalable national program. However, the control can also result in vast differences in program adoption at the state level. Some states will enthusiastically support the program while other states may not recognize the value at the same level.

## Finding Four

### The designation or recognition program may embody different award frameworks.

Some of the organizations studied sponsor a single binary award. This means all awards are the same across the nation. Other organizations have different levels and categories of awards. There are advantages and disadvantages of both types of awards. The single award framework is simpler, can be more standardized nationally and can include a redesignation process. Some organizations did not plan for schools to redesignate, it is just a one-time recognition. Most of these organizations are mainly interested in recognizing institutional or student excellence. Award programs incorporating multiple levels and categories usually include the community membership and are interested in continuous improvement within the service community. Having multiple categories can provide for greater equity and recognition of a broader membership.

## Finding Five

### The award or designation organization needs to include some type of event or multiple events to present the recipients with the award.

The award events for the organizations studied included both a single national award ceremony while other organizations worked with the state educational organizations to present the awards regionally or in each state. There are some examples where organizations have both a regional and national designation event. Much of this is dependent upon the size of the program and the ability of schools to send representatives to a community event.

## Finding Six

### The designation or recognition program needs to determine who receives the recognition.

In studying the designation organizations, we found that different awards are designed to recognize different groups or elements of the organization. Some awards recognize the school administration, staff, faculty and/or students. Other awards are designed to recognize the institution as a whole. The subject of the designation is typically determined by admission and purpose as well as the designation requirements. Many academic programs are designed to recognize the institution as a whole. Designations focusing on workforce readiness typically involve faculty and student performance. It may also include business partnerships and alliances. The recipient of the recognition may also determine how big the national event needs to be and how many attendees will need to be accommodated. One finding the group discovered was the fact that recognition targeting the school administration typically garnered greater local support.

## Finding Seven

### Designation or recognition programs also varied in the type of physical award given to the recipient.

All the organizations analyzed in the study provided some type of physical memento. These mementos included a type of trophy, plaque, banner, PR announcement and/or listing on a website or portal. Some awards included cash prizes, travel cost to an awards event and/or student scholarships. The single time award typically included plaques and financial winnings.

## Finding Eight

### Designation or recognition programs often required criteria that included various aspects of program excellence.

Most academic award programs were based on test scores, student performance criteria and an institution's ability to improve performance and address academic deficiencies. Some of the awards were based on overall competitive score levels while others based the award on improvement. Criteria decisions impact the perception of the award and equity in the designation program. Workforce readiness designations also included alignment of curriculum, student competencies and institutional academic services. Some awards also include business and industry involvement.

## Finding Nine

### Designation or recognition programs also differed in eligibility requirements.

The designation organizations vary greatly in the eligibility for their recognition. Some organizations limited the awards to a membership community. Others limited the number of recipients per state or region. Some of the awards included high school and middle school recipients. In addition, some organizations only recognized publicly funded schools while others recognized both public and private schools. The eligibility requirements typically varied based on the mission and goals of the organization, the size of the program and the popularity

and perception of the designation. Some organizations changed and evolved their eligibility requirements over time. These changes were typically a result of program inequities, funding availability and the ability to manage the size of the overall program.

## Finding Ten

### Award and recognition program sponsorship.

Several of the designations and recognitions programs were able to garner significant business sponsorship. In particular, the Green Ribbon Program in some of the manufacturing programs included a long list of corporate sponsors. These programs also offered generous cash awards and/or sponsorships.

## Finding Eleven

### Program governance and ownership.

Our review of these designation programs revealed very different governance and administration of the application and designation process. Some programs involved national review teams or mentors that reviewed applications and compared award criteria. Other organizations relied on community members to perform the reviews while still other organizations delegated the designation review process for local or state board of education agencies. In many cases these decisions are based on the size of the program and number of applicants.

## Finding Twelve

### Program cost and funding.

Our research identified a variety of different financial models used by the designation and recognition organizations. Some of the organizations had a membership fee that covered the cost of operating the program. Other programs were completely federally funded. Some relied on corporate sponsorships while still others used a mixed model of funding. We were surprised to find schools were willing to fund substantial investments to maintain their membership in some of the high-profile programs. Funding was a major concern for many of the school districts that lacked financial resources.

# APPENDIX E

# High School Feasibility Study: Case Studies

**Tania Williams**
Assistant Director, Center for Cybersecurity Research and Education (CCRE)
The University of Alabama in Huntsville

APPENDIX E

# High School Feasibility Study: Case Studies

## Executive Summary

This case study research was an examination of four existing high school cybersecurity programs to discover factors regarding the programs' development and sustainment. This exploratory study, multiple-case study was intended to better understand the features, factors, and/or issues that apply to the development and sustainment of these programs – specifically, *how* and *why* do high schools develop and sustain cybersecurity programs. This deeper understanding of existing high school cybersecurity programs was intended to inform on the factors that should be considered when looking at ways such schools could be supported and recognized.

The study consisted of interviews of administrators/counselors, teachers, students, and other stakeholders at each of the four sites, with the programs being varied in geographic location, size, and organizational structure. The study found that the main barriers to program creation were lack of resources, lack of teacher training, expense, lack of community understanding, and fear of student actions. One of the programs was created at the state level through the lobbying of industry. Two were created at the district level, with one being a response to a state mandate and one from the district's need to consolidate resources (pulling from existing courses that had developed from cybersecurity clubs). The final program grew from existing cybersecurity clubs at the school and a need to attract more students. The main roadblocks in high school cybersecurity program sustainability were student recruitment, teacher retention, teacher training, technology, underdeveloped curriculum/curriculum maintenance, varied student backgrounds and skills, and keeping up with growth.

# Data Analysis

To better understand how and why high school cybersecurity programs are developed and sustained, the researchers used ATLAS.ti to code and analyze the transcripts from four school visits. The data set, which consists of 29 interviews from four different states having cybersecurity programs, lends itself naturally to qualitative research (Walsh et al., 2015). Therefore, the team took a grounded theory approach to this case study research. The data set itself consisted of interviews from those affiliated with high school cybersecurity programs in four states. One school wished to have its name withheld and will be referred to as Program A. Eight interviews came from Program A. The second school, Troy High School in California, had 7 interviews. The third school, the Institute of CyberSecurity and Innovation (iCSI) in Texas, had 5 interviews, and the final school, Spotsylvania High School in Virginia, had 9 interviews. At each location, the researchers sought interviews from a variety of program stakeholders, including administrators and counselors, teachers, students, and community members (mentors or parents). Therefore, the researchers were able to collect 7

interviews from administrators and counselors, 4 interviews from teachers, 14 interviews from students, and 4 interviews from community members. Table 1 provides a breakdown of the interviews.

| Program | Role | Number of Interviewees |
|---|---|---|
| A | Administrator and/or Counselor | 1 |
| | Teacher | 1 |
| | Students | 6 |
| | Community Member | 0 |
| Troy High School | Administrator and/or Counselor | 2 |
| | Teacher | 1 |
| | Students | 3 |
| | Community Member | 1 |
| iCSI | Administrator and/or Counselor | 1 |
| | Teacher | 1 |
| | Students | 1 |
| | Community Member | 2 |
| Spotsylvania HS | Administrator and/or Counselor | 3 |
| | Teacher | 1 |
| | Students | 4 |
| | Community Member | 1 |

***Table 1.*** Distribution of Interviewees by State and Role

In the interviews, the participants answered open-ended questions detailing how their affiliated high school's cybersecurity program was created and is sustained.

# Approach

## Constant Comparative Coding

Open coding, which is using close examination of data to name and categorizing phenomena, involves breaking the information down into parts (Smit, 2002). Using the constant comparative method of simultaneous coding and analysis outlined by Glaser and Strauss, the researchers compared new data sets with the older ones, constantly adjusting the constructs as it analyzed each data set (O'Reilly et al., 2012). This resulted in continuous reflection and adjustment of coding of the data categories, ensuring fit and relevance (O'Reilly et al., 2012). For example, in trying to capture the methods of roadblocks to program sustainment, the researchers often had to add or rename code types as they progressed through the data. Additionally, as the coding progressed, it became important that the researchers capture any problem areas noted by the interviewees. This resulted in the researchers having to return to previous data sets to capture that information. This happened again as the researchers noted that several interviewees discussed the student recruitment strategies. The researchers decided this was also something it wanted to capture in their analysis, and the members returned to previous data sets to code this information.

Using ATLAS.ti, the researchers were able to attach labels to segments of text, usually sentences or paragraphs; however, occasionally, single words or word groups were sufficient (Smit, 2002). As the coding progressed, certain concepts and categories began to emerge. In the end, the efforts resulted in 3 overarching code groups (creation, description, and sustainment), with program creation having 4 subgroups, program description having 9 subgroups, and sustainment having 3 subgroups. The study also resulted in 276 instances of coding across the 29 interviews. The average number of codes per interview was 9.5, with the highest number of codes in a document being 25 and the lowest being 2. The role of teacher received the highest instances of coding, with 100 of the codes (36.23%) coming from teacher interviews, 83 of the codes coming from administrators and counselor interviews (30.07%), 59 of the codes coming from student interviews (21.38%), and 34 (12.32%) of the codes coming from community members. iCSI's site had the most codes with 103, followed by Spotsylvania High School with 68, Troy High School with 62, and Program A with 43 (see Figure 1).

| | Role: Administrator 6 66 | Role: Stakeholder 4 30 | Role: Student 9 51 | Role: Teacher 4 74 | Totals |
|---|---|---|---|---|---|
| Creation 4 48 | 14 | 7 | 1 | 26 | 48 |
| Description 9 64 | 22 | 6 | 13 | 23 | 64 |
| Sustainment 3 164 | 47 | 21 | 45 | 51 | 164 |
| Totals | 83 | 34 | 59 | 100 | 276 |

***Figure 1.*** Codes by Interviewee's Role

## Theoretical Coding

Next, the researchers put similar concepts into groups (O'Reilly et al., 2012). For instance, the research team noted 3 different factors related to sustainment: student recruitment, other sustainment factors, and roadblocks to sustainment. These subgroupings under sustainment were further broken down as indicated by Table 2.

Creation and description groupings were broken down in a like manner. This axial coding allowed the team to make sense of the data and detect patterns.

| Code Group | Code Subgroup | Code |
|---|---|---|
| **CREATION** | Creation: How did the cyber program develop? | |
| | Creation: Lessons Learned | |
| | Creation: Lessons Learned | Collaborate with Experts |
| | Creation: Lessons Learned | Don't Rush into Anything |
| | Creation: Roadblocks | |
| | Creation: Roadblocks | Fear of Student Actions |
| | Creation: Roadblocks | Lack of Money |
| | Creation: Roadblocks | Lack of Teaching Resources |
| | Creation: Roadblocks | Lack of Trained Teachers |

| | | |
|---|---|---|
| | Creation: Roadblocks | Lack of Understanding of Cyber |
| | Creation: Why did the cyber program develop? | |
| | Creation: Why did the cyber program develop? | Leadership Driven |
| | Creation: Why did the cyber program develop? | State Mandated |
| | Creation: Why did the cyber program develop? | Student, Parent, or Community Interest |
| | Creation: Why did the cyber program develop? | Teacher Driven |
| **DESCRIPTION** | Description: Age of Program | |
| | Description: Age of Program | One year |
| | Description: Age of Program | Three years or more |
| | Description: Age of Program | Two years |
| | Description: Articulation Agreements | |
| | Description: Articulation Agreements | No |
| | Description: Articulation Agreements | Unknown |
| | Description: Articulation Agreements | Yes |
| | Description: Community Connections | |
| | Description: Curriculum | |
| | Description: Curriculum | Combination of Resources |
| | Description: Curriculum | Teacher Made |
| | Description: Extracurricular | |
| | Description: Professional Development | |
| | Description: Program Achievements | |
| | Description: Program Achievements | CyberPatriot or other competition finalists |
| | Description: Program Achievements | Teacher Recognition |
| | Description: Program Type (CTE, CS, Other) | |
| | Description: Program Type (CTE, CS, Other) | Computer Science |
| | Description: Program Type (CTE, CS, Other) | CTE |
| | Description: Program Type (CTE, CS, Other) | Other |
| | Description: School Type | |
| | Description: School Type | Magnet |
| | Description: School Type | Other |
| | Description: School Type | Private |
| | Description: School Type | Public |
| **SUSTAINMENT** | Sustainment: Other Sustainment Requirements | |
| | Sustainment: Other Sustainment Requirements | Industry Partners |
| | Sustainment: Other Sustainment Requirements | Inspiring Teacher |
| | Sustainment: Other Sustainment Requirements | Mentors |
| | Sustainment: Other Sustainment Requirements | Rigor |
| | Sustainment: Roadblocks | |
| | Sustainment: Roadblocks | Disinterested Students |

| | | |
|---|---|---|
| | Sustainment: Roadblocks | Funding |
| | Sustainment: Roadblocks | Keeping up with Growth |
| | Sustainment: Roadblocks | Rural |
| | Sustainment: Roadblocks | Scheduling |
| | Sustainment: Roadblocks | Student Recruitment Challenges |
| | Sustainment: Roadblocks | Teacher Retention |
| | Sustainment: Roadblocks | Teacher Training |
| | Sustainment: Roadblocks | Technology |
| | Sustainment: Roadblocks | Undeveloped Curriculum |
| | Sustainment: Roadblocks | Updating Curriculum |
| | Sustainment: Roadblocks | Varied Student Skills |
| | Sustainment: Student Recruitment | |
| | Sustainment: Student Recruitment | Community Outreach/Camps |
| | Sustainment: Student Recruitment | Competitions |
| | Sustainment: Student Recruitment | Counselors |
| | Sustainment: Student Recruitment | Parent Nights/Classroom Visits |
| | Sustainment: Student Recruitment | Student Teaching/Mentoring |
| | Sustainment: Student Recruitment | Student Awards/Certifications |
| | Sustainment: Student Recruitment | Student Internships |

***Table 2.*** Axial Coding of Code Groups and Codes Using ATLAS.TI

## Theoretical Sampling and Saturation

As the amount of interviews was constrained by time and the availability of the participants at the location, theoretical sampling as means to guide the next data source was limited. Instead of being naturally lead "from participant to participant as new conceptual ideas are captured," the researchers used the available participants as a means to see the theory develop. In the spirit of theoretical sampling, the researchers did allow the available data set to guide and shape what it was searching for and why (O'Reilly et al., 2012). The data set of four sites defined the theoretical saturation of the analysis as no other data sets were sought (O'Reilly et al., 2012).

## Theoretical Sensitivity

Working off the existing open codes, an insight to the data's meaning began to emerge (O'Reilly et al., 2012). As the focus of the research is the creation and sustainment of high school cybersecurity programs, patterns related to this research focus were identified and categorized. From these categories, observations regarding creation and sustainment began to lend insight on varying ways high school cybersecurity programs come into being and are able to remain functional. This insight is further explained in the results section.

# Results

In order to answer the question *how are high school cybersecurity programs developed and sustained*, we first decided to look at the current status of each program. This was achieved through capturing factors such as the school structure, how the program fits inside the school, the program's age, and the program's accomplishments. Additionally, the researchers sought to understand how the programs were created and how the programs continue to exist.

## Program Descriptions

The 4 sites located in four different states vary greatly in school size and program type. Program A is a small magnet school centered solely on cybersecurity, engineering, and technology where all students benefit from focused cybersecurity classes as well as cybersecurity being integrated in their core content areas. All newly enrolled students take AP Computer Science Principles as an introductory course. The school has been in existence for two years. The school benefits from the support of industry leaders, allowing the school to provide hands-on, practical learning experiences for students.

Troy High School is part of a much larger magnet school, and the cybersecurity courses function as part of the magnet's career technical education (CTE) program. The school pulls students from neighboring school districts and depends on recruitment in order to sustain the school. The cybersecurity program at the school has existed for over three years and has built student teams who have been strong competitors in national cybersecurity competitions.

iCSI uses a vocational/technical school format, with interested students commuting to the location from their home school to take the cybersecurity courses offered as part of their school day. The program, allowing for CTE credit, is in its first year of existence but has grown from existing cybersecurity programs at the home schools within the district. Teams from the home schools have also finished strongly in national cybersecurity competitions.

Finally, Spotsylvania High School sits as a CTE course in a rural public high school. The program is more than three years old, with the teacher receiving national recognition (see Table 3).

| Location | Type of School | Age of Program | Achievements |
|---|---|---|---|
| **Program A** | Small STEM magnet school | 2 years | Unique opportunities for students through industry partnerships |
| **Troy High School** | Large magnet school | Over 3 years | Finalists in national cybersecurity competitions |
| **iCSI** | Cybersecurity center, servicing a school district | 1 year | Finalists in national cybersecurity competitions |
| **Spotsylvania High School** | Rural high school | Over 3 years | National teacher recognition |

***Table 3.*** Description of Case Study Sites

## Program Creation

As far as cybersecurity program creation, the schools were grown from action at the state or district levels; however, the influencing factors spurring this creation vary. Program A was created at the state level. The school itself was created in 2018, when the governor of the state signed legislation creating the school, and in 2020 the school opened its doors to students in the middle of the COVID pandemic. Troy High School and Spotsylvania High school were created at the district levels. For Troy High School, the district created the program at five of their schools and recruited interested existing teachers to develop the curriculum and teach the courses. However, Troy High School was established upon the suggestion of the teacher as a means to increase school recruitment and build upon the interest in cybersecurity that already existed through cybersecurity competitions. iCSI grew out of existing programs that also originated from participation in cybersecurity competitions, allowing the district to consolidate instructional resources and provide a centralized and isolated network for student instruction (see Table 4).

| Location | Program Created Through |
|---|---|
| Program A | State legislation and support of local professional organizations. |
| Troy High School | Existing cybersecurity clubs and need to recruit more students. |
| iCSI | District's need to consolidate resources. |
| Spotsylvania High School | District's response to a state mandate. |

***Table 4.*** Enablers for Program Creation

When discussing creation roadblocks, the four sites listed factors such as fear of students' actions, lack of money, lack of teacher resources, lack of teacher training, and a lack of understanding of cybersecurity careers (see Figure 2).

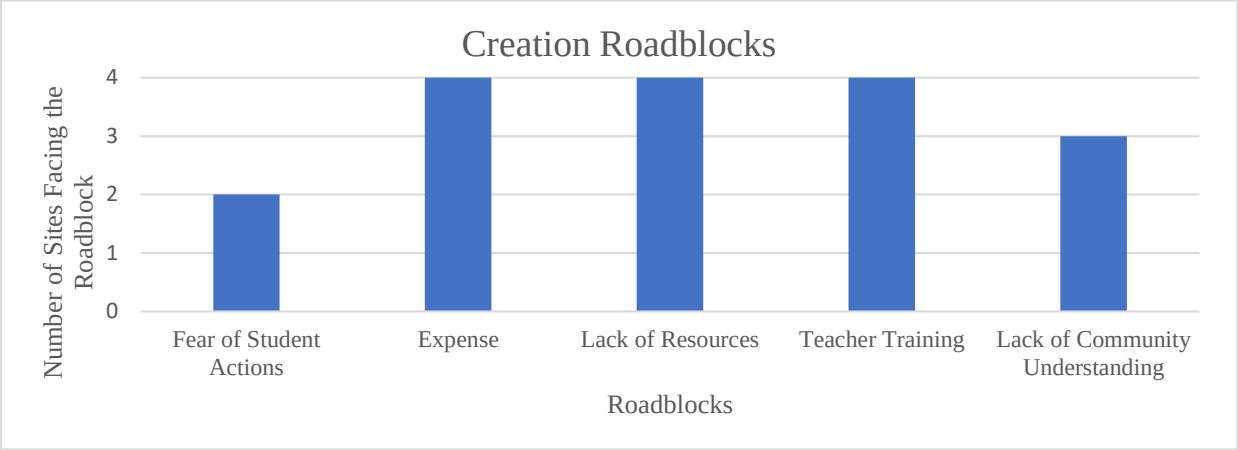



***Figure 2.*** Roadblocks to Program Creation

Two sites mentioned fear of student actions as a roadblock to program creation. As one stakeholder described, "One of the issues that we have nowadays is some people are so scared of the term virus or malware or hacking or things like that. And so, what they actually do is hinder a lot of our students from progressing and learning." Another remembered, "I said these district images are on lockdown. I can't have kids do anything." The schools mentioned that educating stakeholders and putting students on isolated networks (either a physical network or using a cyber range) were ways of overcoming this roadblock to creation.

Another barrier was the expense of creating a cybersecurity program. One volunteer mentor mentioned spending money out-of-pocket for resources. He noted, "One of the other pieces is it is really hard to do computer science or computer technology without computers. . . I've dumped about $10,000 in my own funding into it [the program], just because it's a passion." A teacher at a different location mentioned having to find funding for monitors. Another teacher, who saw the program grow from a cybersecurity competition, noted, "The school network was not good enough. We had to compete at one of the kid's houses." The need for a network (either physical or virtual) was noted as a roadblock among 3 of the sites, with the remaining site having access to a state-sponsored cyber range. One of the administrators expressed concerns about funding space to even house the program, noting the district had to invest in new facilities. To overcome funding roadblocks, the sites reported strategies ranging from relying on equipment and monetary donations, soliciting funds through legislation or grants, or even using school bonds for new facilities.

In addition to having the needed equipment and space, sites also noted the difficulty in finding teaching resources. Teachers at all four sites noted the lack of existing cybersecurity curricular resources at the creation point of their programs. They report patching together teaching materials from GenCyber camps and CyberPatiot resources. Additionally, they report making their own learning modules for students to use, with all four teachers trying to align with industry certifications to varying degrees. "I write all the curriculum . . . It's based on a lot of throwing things against the wall for the last eight years, right? I have created a lot of lessons that I have archived," said one teacher. Another teacher described the challenge: "Over the next year, we

started developing just lessons, and I was like 'No, we need a pacing guide.' So I reviewed the competencies, went through and broke everything down, and built a pacing guide." The schools also mentioned the lack of curriculum as an ongoing obstacle for the program, citing changing technology and the need to build advanced courses for continued student growth. As one teacher from a different location noted, "My background is programming . . . I am part of the cyber department, but I'm not the main part of it. The intent was to hire a cyber SME . . .The SME [subject matter expert] was to go on and develop what we were going to do. Now we've kind of gone a different route with that." To meet these challenges, both administrators and teachers mentioned the need for professional development time and for access to subject matter experts to allow teachers the time and the expertise to vet existing resources and to create their own resources as needed.

Building content area expertise was also noted as a roadblock for program creation. Not only do teachers need to the resources to teach, the administrators and teachers at the sites stressed the need for trained cybersecurity teachers. Among the 4 sites, 2 schools had teachers with computer science or IT backgrounds. The other two teachers switched over to cybersecurity from a different content area. One of these teachers noted, "We did TestOut the first year, and it was me staying ahead by two weeks . . . Fortunately, I had kids that were tolerant of the fact that I was pushing TestOuts all the time. One of my goals over the long run was to get away from [them], learn the TestOut myself, and figure out ways to do it my way and not to use TestOut." The teacher, who is self-taught, now has several industry certifications. Both of the teachers without formalized computer science or IT training also relied on mentors to assist with instruction. "I didn't know anything," another teacher recalled. "I was trying to find experts to come in and teach us . . . It was very painful the first year." One site mentioned the difficulty in getting teachers credentialed by the state to teach cybersecurity as a roadblock. All 4 sites saw the need for trained teachers as an ongoing problem. This is discussed further in the Program Sustainment section.

The final roadblock to program creation mentioned by the sites was the lack of understanding of cyber careers. This lack of understanding was seen when dealing with administrators, counselors, parents, and students. "A previous superintendent walked into my classroom one day, and I showed him the CyberSeek.org website," one teacher recalled, "and then a lightbulb went off for him. He was like 'You're offering my grads jobs. What do you need?'" Student benefits had to be communicated to counselors also. "I don't know if *roadblock* is the right word, but a challenge was counseling. Yeah, making sure that they [counselors] understand the program and what it all entails. And again, I think that's a revolving door with counselors and career technical education," noted an administrator at one of the sites.

This messaging extended to communication with parents and the general community, stressing the benefits of the program and the purpose of the content. One teacher noted, "We were very purposeful with cyber defense to kind of sell it to all the adults out there." Another administrator noted the difficulty in making the community understand the field of cybersecurity and opportunities the field offers. The administrator stated, "We did a survey. 'Hey, what are you folks interested in? What is our community interested in?' And to be honest, the survey results were not extremely high saying cybersecurity. But when we started digging into the results and started looking at, you know, the up and coming job market, our realization became that, it's because people don't know what it is. They didn't understand what cybersecurity did and the opportunities that were there for their students." To get around this obstacle, the schools mentioned several strategies including leveraging extracurricular activities, parent nights, working closely with counselors, touting program

achievements, and developing connections with industry. These strategies are discussed in the Program Sustainment section.

## Program Sustainment

In addition to understanding how high school cybersecurity programs develop, it is also important to understand how they are sustained. When interviewing individuals tied to the cybersecurity program at the 4 sites, discussion of sustainment focused on the need for student recruitment. However, the individuals also discussed other sustainment requirements unique to their program and roadblocks associated with keeping the program running.

### Student Recruitment

Interviewees at all 4 sites listed student recruitment as a need for being able to sustain their cybersecurity programs, and all the schools had recruitment strategies in place. However, the need to actively recruit students varied among the 4 sites. Admission to 2 of the programs was competitive, with one site requiring potential students to complete an application, obtain a letter of reference, and undergo an interview. The other site had a lottery system where interested students' names were added to a pool and students' names were then selected to fill the limited number of seats in the program. The teacher at one of the other two sites mentioned having a heathy program with a steady pool of interested students, and the teacher credited this to good counselors. The teacher said if enrollment increased by two or three students, the school would begin wait listing students for the courses. The last site mentioned student recruitment as a big concern, with one of the counselors stating, "One of our challenges, which wouldn't be every schools, is attracting students. So, you know, there is a risk there." The teacher at the site also expressed concern about student numbers and stated, "We've got to keep our numbers up."

To maintain student interest in the programs, the schools mentioned strategies such as community outreach and camps (2 schools), competitions (4 schools), counselors (4 schools), parent nights or classroom visits (3 schools), student awards and certifications (4 schools), potential of student internship opportunities (4 schools), and use of students to mentor/teach younger students (3 schools).

### Other Sustainment Requirements

While the need for students is a commonality among the sites interviewed, the schools mentioned other sustainment factors unique to their programs. For example, at one of the schools, every interviewee mentioned having an inspiring/passionate teacher was the most important factor to the program's success. When talking about why the school's program was successful, one parent noted, "I can't say enough good things about the program. Oh, I think with all the things with all programs, a majority of the program is who's leading it and who's teaching." The parent went on to explain how his son was autistic and how open the teacher was to making sure the student's needs were being met. The administer of the school echoed the parent's praise stating, "Yeah, some [programs] are more successful than others, but I think it's because of the instructor." The students interviewed also mentioned being inspired by the teacher's passion for "helping people learn more about cybersecurity and what it means in every aspect of your life."

For another school, the key to sustainment was industry partners and parents. The counselors at the school noted the students attending the school had unique internship opportunities that make programs like cybersecurity attractive to students and beneficial to the community. In fact, students get 150 hours of internship placement between their junior and senior years. This connection with industry allows the students to make connections to businesses and also allows them to build other employable skills. Additionally, the teacher runs the cybersecurity program similar to a sports team – complete with a parent booster club. This booster club focused on fundraising efforts for the school and supported the program's extracurricular activities.

Two of the schools felt a major factor in sustainment was their use of mentors. At one school, adult mentors were used to maintain equipment and coach extracurricular teams tied to the program. Additionally, student mentors are used to teach/tutor younger students, serving as teaching assistants for the classes. Stakeholders and students at the school both stressed the value of peer to peer collaboration. "I find that my peers are my greatest encouragement in learning new concepts," one student said. "The expectation here . . . to teach the lessons to their peers. I think that's a big thing as well that I enjoy about what's fostered by this program is, as you go up in grade levels, you get more and more teaching opportunities, where we try to encourage our students to teach other students, because the most important thing is not only do you learn the knowledge but can share the knowledge with others. It's awareness and soft skills. Teaching the big thing." The other school used students to mentor middle school students, helping to grow the program.

One of the four schools stressed that maintaining rigor was an important factor to school sustainment, noting that their rigorous program helped set their program apart from neighboring programs. This theme was echoed by the student interviewees. "It's a big thing that they actually go more in depth with security than other schools do," said one student. Other students stressed the importance of rigor, with one student saying, "they [the teachers] do more actual work application. . . They walk you through how it's going to affect your actual work, and that's the main focus of our school is to get us prepared for an actual job. So, as soon as we graduate, we can take a job wherever we want and know what we're doing."

### Sustainment Roadblocks

Of course, just as there are factors required for program sustainment, there are also challenges that stand in the way of the program continuing. The 4 schools mentioned 12 challenges related to their programs (see Figure 3). The challenges are as follows:

- Disinterested students: one school mentioned some students enrolling in the course but do not find the content engaging enough to continue. This impacts retention numbers and the actions and attitudes of these students can also impact the experiences of other students in the course.
- Funding: Administrators from two schools noted the programs were expensive to maintain. One school will not be able to expand the program as planned without extensive renovation of a building.
- Keeping up with growth: Three schools mentioned concerns about being able to meet the current demand for the courses associated with their programs. Two the schools had already exceeded capacity, while another school was nearing maximum capacity.
- Being in a rural area: One school mentioned that being in an area that was not near a lot of cybersecurity related jobs made it more difficult to build interest in the program.
- Scheduling: One school found scheduling students for the courses a challenge.

- Student recruitment: As mentioned earlier, one school felt that they had to maintain a high level of student interest for the program to continue. All schools saw student recruitment as a priority.
- Teacher retention: All the schools mentioned the programs were currently very dependent on keeping their cybersecurity teachers. One school had experienced a high turnover in cybersecurity teachers, which impacted the continuity of the topics taught across the program and the schools ability to offer certain classes.
- Teacher training: All of the teachers expressed a desire for more training. Some wanted content specific training, while other desired training on pedagogical strategies. Of interest, one student also noted the gap in teaching expertise: "Teachers that come in aren't actually teachers. They're just professionals now doing stuff with students. We have that kind of gap in like education training."
- Technology: Teachers noted two frustrations with technology. One was being able to acquire and maintain technology. The other was working with the IT departments at the school in using the technology. Two different teachers expressed having problems with blocked sites and having a hard time getting the sites whitelisted.
- Undeveloped curriculum: All the schools mentioned the lack of curriculum options, especially for 2nd to 4th year students in the program. All the teachers mentioned the burden of having to make their own materials. At one location, the students also commented on the lack of an established curriculum.
- Updating curriculum: Two of the teachers expressed concern with using outdated resources and constantly having to update lessons due to changes in the field.
- Varied student skills: Interviewees from all roles and from 3 of the schools mentioned the range of student ability in the classes and the difficulty of teaching students with very limited computer skills in the same class with students who already have a high level of technical expertise.

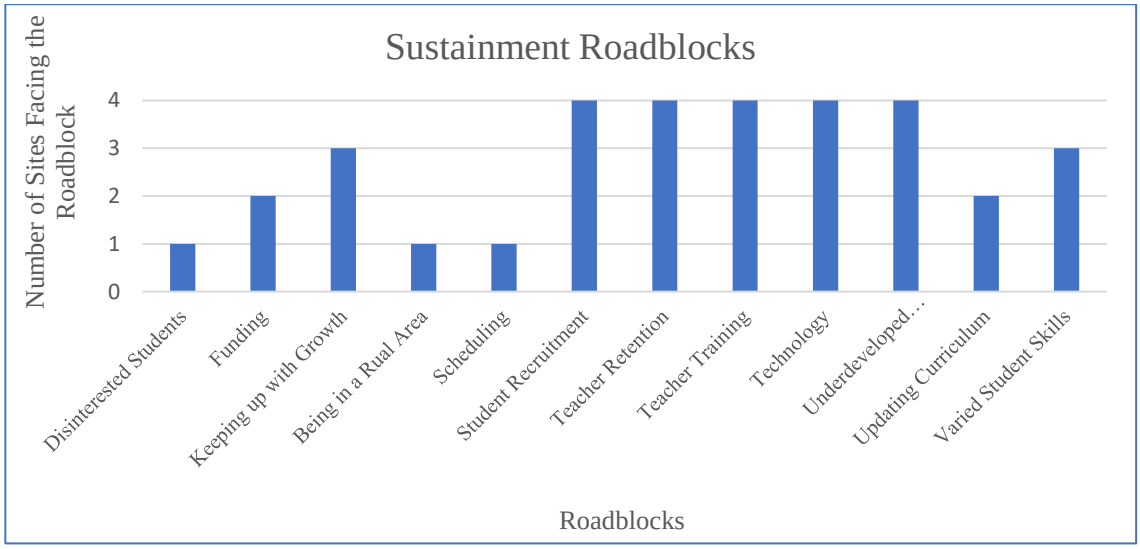



***Figure 3.*** Roadblocks to Program Sustainment

# Conclusion

The case study data set indicates that nationally recognized cybersecurity programs can be created in a variety of school structures and program formats. Two of the school programs started as student competitions, one started through state legislation, and the other was created by a decision at the district level in response to a state mandate. Each school was geographically dispersed and varied in size and structure. The programs themselves were also dissimilar. However, there were common challenges in creating these programs. Challenges mentioned included fear of student actions, the expense, lack of resources, lack of teacher training, and lack of community understanding regarding the field of cybersecurity.

Even after overcoming these roadblocks, there still exists challenges to program sustainment. Common roadblocks faced by all four sites are student recruitment, teacher retention, teacher training, technology, and underdeveloped curriculum. Student disinterest, funding, keeping up with growth, school location, scheduling, keeping the curriculum current, and varied student skills were also mentioned by at least one of the sites.

When relating these needs to a program of excellence, the fragility of the programs stands out. While these programs have all received national attention – whether through their unique structure, teacher recognition, or success with student certifications and competitions – each program is very dependent on teacher retention and the teacher's ability to develop and maintain teaching resources. These programs are certainly excellent in their resourcefulness, creativity, and dedication to student learning; and each school will need continued support and development to ensure that the school can continue to survive and thrive in the ever-changing and ever-growing field of cybersecurity education.

## Ethical Approval

The study obtained ethical approval from The University of Alabama in Huntsville's Institutional Review Board of Human Subjects Committee (EE20228). All participants consented to take part in the study.