Computer Science as a Graduation Requirement:

A Landscape Analysis Report

MASSACHUSETTS
Department of Elementary and Secondary Education

SAGEFOX CONSULTING GROUP

CS FOR MA

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Purpose

In the Massachusetts **Economic Growth and Relief Act (Chapter 268)**, the Legislature asked for a recommendation on a graduation requirement for a foundational CS course. In mid 2023, in order to understand the scope of such a requirement, the Massachusetts Department of Elementary and Secondary Education (DESE) commissioned SageFox Consulting Group and CSforMA, Inc. via a competitive RFR procurement process to conduct (1) a National Landscape Analysis Report and (2) a Recommendation Report for a foundational CS course requirement for high school graduation for the state of Massachusetts. The Landscape Report is designed to learn what it takes to make Computer Science (CS) a high school graduation requirement by examining states that are already implementing it. Much of this complexity can be attributed to policy levers that differ by state, critical funding strategies and the varying influencers of important advocacy approaches.

Executive Summary

Over the last decade the Computer Science for All initiative has led states to consider how to embed computer science (CS) education more deeply into the core course of study for K–12 students. Many states are now at an inflection point; efforts to support the voluntary integration of computing education into the curriculum have reached saturation. To achieve greater and more equitable reach additional policy levers, such as a high school graduation requirement, are being considered. For every state considering a graduation requirement, three key questions must be explored:

	Question	Considerations
1	**What is the purpose of a graduation requirement? What problem would the graduation requirement solve?**	What values drive the policy design and implementation? For example, is a state focused on developing a workforce, preparing students for higher education, or developing well-rounded citizens?
2	**If a graduation requirement is the best solution to the problem, how could it be structured and implemented?**	What level of CS education should be required to fulfill the purpose? What are the policy opportunities to ensure equitable CS in the K–12 system? What support is needed for robust implementation?
3	**What are the costs and benefits of a graduation requirement?**	How much does it cost to do this work well? What is gained by including a CS requirement for graduation? What are the risks of including the requirement (particularly for students)?

At the time of preparing this report, eight states include some CS education as a high school graduation requirement, each of them at a different phase of implementation.

ARKANSAS

REQUIREMENT: A CS course which can count as a 4th math, 3rd science or career-focused requirement.

Year of Legislation: 2021

Year Fully Implemented: Required for 9th grade class 2022

**State Funding Non-Recurring:* $28 million

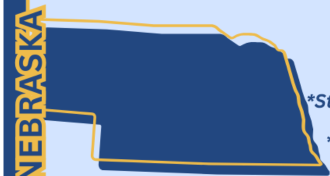
**State Funding Recurring:* $3.5 million

**Recurring Funding Purpose:* PD, tuition waivers for pre-service teachers

Mechanism: Legislative

Prior Legislation: Yes

NEBRASKA



REQUIREMENT: One semester of Computer Science

Year of Legislation: 2022

Year Fully Implemented: Class of 2028

**State Funding Non-Recurring:* No

**Recurring Funding Purpose:* No

Mechanism: Legislative

Prior Legislation: No

NEVADA

REQUIREMENT: Half credit (One semester) "computer education and technology". The course must include at least 50% CS and computational thinking.

Year of Legislation: 2019

Year Fully Implemented: Required for graduating class of 2023; course available in 2019

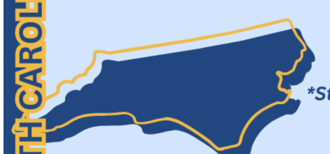
**State Funding Non-Recurring:* $4 million

**Recurring Funding Purpose:* PD (in-service and pre-service)

Mechanism: Legislative

Prior Legislation: Yes

NORTH CAROLINA



REQUIREMENT: CS course in place of an existing elective

Year of Legislation: 2023

Year Fully Implemented: 2024–25 academic year

**State Funding Non-Recurring:* $8 million

**State Funding Recurring:* No

Mechanism: Legislative

Prior Legislation: No

NORTH DAKOTA

REQUIREMENT: One unit of CS or cybersecurity. Can fulfill a unit of mathematics or science as part of a sequence.

Year of Legislation: 2023

Year Fully Implemented: After July 31, 2025

State Funding Non-Recurring:* $600,000

**State Funding Recurring:* Yes, unspecified

Mechanism: Legislative

Prior Legislation: No

RHODE ISLAND

REQUIREMENT: Proficiency requirement (via a course or other method)

Year of Legislation: 2022

Year Fully Implemented: Class of 2028

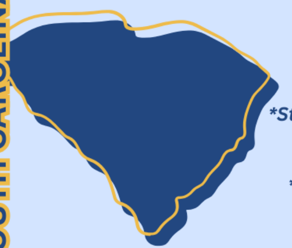
**State Funding Recurring:* $210,000

**Recurring Funding Purpose:* PD, BPC with priority to Title I schools

Mechanism: Department of Education set requirement

Prior Legislation: No

SOUTH CAROLINA



REQUIREMENT: Full-year course

Year of Legislation: 2018

Year Fully Implemented: 2019–20 academic year

**State Funding Non-Recurring:* $7.4 million

**State Funding Recurring:* $500,000

**Recurring Funding Purpose:* PD & Certification

Mechanism: Department of Education set requirement

Prior Legislation: Yes

TENNESSEE

REQUIREMENT: Full-year high school CS course

Year of Legislation: 2022

Year Fully Implemented: 2024–25 academic year

**State Funding Non-Recurring:* $1.3 million

**State Funding Recurring:* $1.3 million

**Recurring Funding Purpose:* PD, implementation of graduation requirement, and development of strategic plan

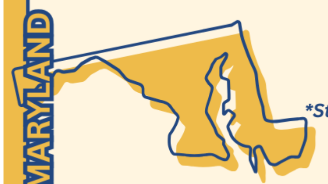
Mechanism: Legislative

Prior Legislation: Yes

**Funding does not include grants and gifts from outside of the state-level departments of education.*
*** This funding is connected to cybersecurity training pursuant to HB 1398, which created the graduation requirement, a requirement for high schools to offer cybersecurity and CS courses, and an adult education grant program. However, it is unclear if any portion of the funds went to K-12 CS education."*

Policy levers used by other states to create more CS opportunities and incentives including allowing credits earned in CS courses to count towards graduation (often as a math, science or technology credit), requiring all schools to offer CS or admission into state-run higher education institutions requires a CS credit:

CS POLICY:	All high schools to offer computer science
Year of Legislation:	2020
Year Fully Implemented:	2022
**State Funding Non-Recurring:*	$500,000
**State Funding Recurring:*	$500,000
Mechanism:	Legislative
**Recurring Funding Purpose:*	PD
Prior Legislation:	Yes



CS POLICY:	One credit of "Computer science, engineering, or technology education"
Year of Legislation:	2017
Year Fully Implemented:	Required for Incoming Freshmen 2021-2022 School year
**State Funding Non-Recurring:*	One time $5 million allocated for initiative, one time $7 million for teacher PD
**State Funding Recurring:*	Annual $1 million allocated
Mechanism:	Legislation
Prior Legislation:	No

CS POLICY:	Technology or Computer Science Course (1 Carnegie Unit). All schools high schools required to offer CS
Year of Legislation:	2018 all public schools required to offer CS
Year Fully Implemented:	Students admitted in Fall 2023; 2024-2025 academic year all public schools offer CS.
**State Funding Non-Recurring:*	$2 million (with additional $1 million in private funding)
**State Funding Recurring:*	No
Mechanism:	Department of Education
Prior Legislation:	Yes

CS POLICY:	Digital Studies Requirement, half credit requirement for high school students, must take one of six approved courses
Year of Legislation:	2019
Year Fully Implemented:	2019 (K-5), 2020 (6-12)
**State Funding Non-Recurring:*	$16.5 Million for initiative
**State Funding Recurring:*	None
Mechanism:	Legislation
Prior Legislation:	No

**Funding does not include grants and gifts from outside of the state-level departments of education.*

Launched in 2016, the CS for All initiative spurred a national commitment to CS in K–12 education between government, industry and community. This report provides an opportunity to learn from states that have already developed CS graduation requirements. The speed at which states have established policies around CS education is unprecedented.

According to data collected by code.org, MA is 12th in the nation in the percent of students who are taking a foundational CS course. Most of the states above MA in Figure 1 have had CS related policies in place for years including the top four who have strong CS policies. As other states begin to implement their robust CS policies there will likely be a significant shift in which states lead the way in CS participation.

There is a lot to be learned about seeding and defining these requirements. Given how recently many states have implemented CS requirements, it's still early to be able to state the consequences, and impacts, of these requirements. Thus, this report provides themes that should be considered and understood when defining and designing policy within local contexts and examples from across the nation. The second phase of this study will translate the findings from the landscape analysis into a set of recommendations for the Massachusetts context, based on input gathered from stakeholders such as educators, administrators, parents, students and community members across the state.

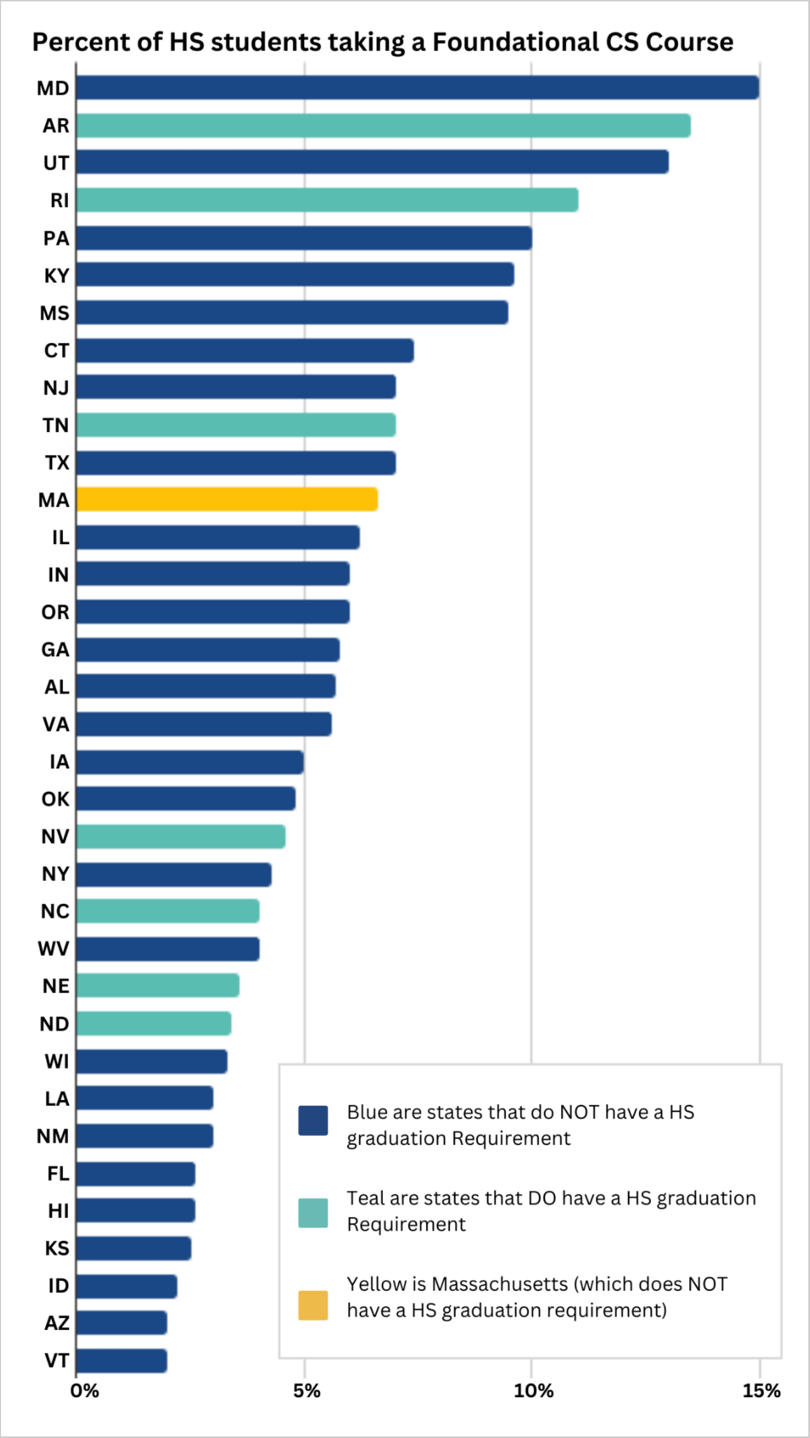


Figure 1. Chart: Percent of HS Students taking a foundational CS Course. This data was taken from the 2023 State of CS report

Introduction

The CS Ed Initiative

Over the last ten years, there has been a significant investment in CS education across the nation. Many of the efforts to bring CS into states were grassroots, led by invested individuals and small groups, with a focus on teacher professional development (PD) and the creation of curricular materials.[1] In 2016 President Obama called for Computer Science for All, raising the national profile of CS education and allocating additional CS-specific funding through the National Science Foundation, the Corporation for National and Community Service, and the U.S. Department of Education.[2] [3]

> **CS For All**
>
> Computer Science for All is the President's bold new initiative to empower all American students from kindergarten through high school to learn computer science and be equipped with the computational thinking skills they need to be creators in the digital economy, not just consumers, and to be active citizens in our technology-driven world. Our economy is rapidly shifting, and both educators and business leaders are increasingly recognizing that computer science (CS) is a "new basic" skill necessary for economic opportunity and social mobility.
>
> *- The White House, January 30 2016*[4]

Through significant political attention, federal investment, industry engagement and investment, teacher support, curricular resources and the development of coordinated learning communities the CS for All movement made CS a fundamental component of the K–12 educational experience nationwide.

The CS for All initiative led to broad-based support and learning at the national level that individual states then harnessed and tailored to their local contexts. For example, states in the Expanding Computing Education Pathways (ECEP) Alliance[5] developed a collective impact model for making state change. Although each of the 30 member states has a unique context they work together to consider how to make equity-explicit policies, programs and practices in support of CS education. This approach creates a shared language and framework for states to make change. Massachusetts was a founding member of the ECEP alliance in 2011.

Importance of Policy Changes

Without official policy change, computer science programs may only reach certain members of the public—potentially exacerbating inequities. Policy initiatives codify reforms to our laws, regulations and institutions. Often existing policies may run counter to new discoveries and developments; therefore, policy change is required to enact new programs and requirements that apply broadly and ensure they are funded. Working in conjunction with grassroots efforts, policy reforms can reflect public opinion by having a far-reaching, sustainable impact.

CS education occurs in a complex ecosystem of people, monetary resources, organizational support, educational initiatives, legislation and other intangibles like public support. We conducted a review of over 500 documents, including legislation and other policy documents, media reports, state landscape reports, data dashboards and other publicly available sources. Important themes that emerged include:

- Setting a state vision for CS
- The various ways a CS requirement can be defined
- Which courses fulfill the state requirements
- The role of advocacy organizations and other groups in organizing the state policy efforts
- Funding structures to support CS implementation
- Building the institutional capacity to implement a CS requirement
- Monitoring the implementation of the requirement

Key Themes

A State Vision for CS

Setting a state vision for CS can help guide policy and implementation decisions as CS becomes embedded into the K–12 milieu, providing a sense of direction and purpose. According to code.org 30 states have a published plan for CS education. These plans often share the vision. This vision may come about through top-down means such as governor's initiatives, or develop organically through grassroots efforts led by teachers, families or other CS advocates.

Strategic Plans

Many states have strategic plans that articulate their vision for statewide CS education. These are important documents for guiding and organizing a variety of stakeholders as decisions concerning implementation and resource allocation are made. Goals and timelines for CS expansion within the states are laid out within the plans. Values that drive the states' commitment to CS are articulated in the plans either implicitly or explicitly.

When examining states that either require CS for high school graduation or have other strong CS efforts like ensuring all schools offer CS, two non-mutually-exclusive drivers for these strategic plans typically exist: building a workforce or diversifying an existing workforce.

Skills For The New Economy

Providing students with awareness of and skills for a technology-based pathway is critical. Computing skills are critical for many gainful employment opportunities in MA, beyond the technology, biotechnology and other STEM workforce sectors. The 2018 report from [Boston-based Burning Glass Technologies][6] examined 150 million unique job postings across the nation listed since 2007 and identified 14 critical skills (Figure 2) that are now foundational for the new economy. Though many states, including MA, require a technology-enabled workforce, technology and digital literacy go beyond the technology sector. MA DLCS standards were created with the aspiration that "students of all backgrounds should be prepared for personal and civic efficacy in the twenty-first century and should have the opportunity to consider innovative and creative technology-based careers of the future." The fundamental career skills which are human skills, digital building blocks and business enablers are all supported with technology-based tools.

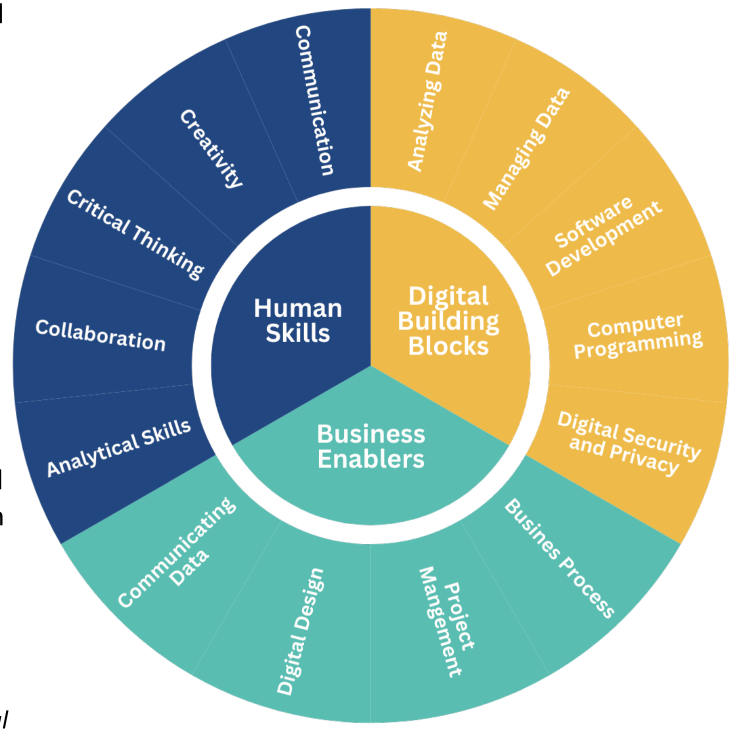


Figure 2: New Foundational Skills for the Digital Economy

Building a Tech-Enabled Workforce

Computer science education is not only relevant to the technology industry and can prepare students to pursue a variety of careers. Yet, states are often politically motivated by the local workforce demands. These needs are driven by the rise of technologies and technologically-enabled services (such as Remote Operations, Social Media, Data Analysis and Artificial Intelligence [AI] to name a few) being deployed across all industry sectors. Job requirements are evolving more expansively than ever. This makes it hard for companies to find qualified workers and for individuals to qualify for good jobs. To attract and or retain companies, states are looking at ways to become more competitive with talent development rather than relying on those with requisite skills to come to the state. This includes creating minimum computational competencies that all students should meet in K–12 for college and career readiness, thereby inspiring and developing talent within the state. This has led to the adoption of CS as an academic area that can develop those skills and interests among students in an effort to build a future workforce. Within this category, we see states that have an existing technology industry for which they are developing future talent, such as New Jersey and North Carolina, or those that are working towards building a technology-driven economy, like Kentucky and West Virginia.

- **North Carolina** has an existing tech industry presence but a limited pipeline of students working towards those jobs. In a report to the North Carolina General Assembly, NC Superintendent Mark Johnson and Lt. Governor Dan Forest state, "In fact, North Carolina has more than 18,000 unfilled computing jobs with an estimated $1.5 billion in annual salaries available, yet there are fewer than 6,000 students enrolled in CS courses across the state. If we do not equip our students with the proper education and training to fill these jobs, North Carolina will not be able to attract and retain this industry."[7]
- Similarly, **New Jersey** seeks to develop a more robust workforce by motivating students to pursue careers in CS. The state plan notes that "in New Jersey, there are 15,237 open computing jobs spanning every industry. The average salary for a computing occupation in New Jersey is $107,260, which is significantly higher than the average salary in the State ($56,970). The existing open jobs alone represent a $1,634,319,249 opportunity in terms of annual salaries. But in 2017, only 1,642 Computer Science majors graduated from the State's universities."[8]
- The **Kentucky** Department of Education is focused on building technological workforce capacity to fill existing job openings and stimulate the state's economy, with the Department stating "by creating more opportunities for computer science learning for Kentucky students, we will reach, keep and engage more students in learning, create a pool of more qualified people to fill existing job openings and stimulate suppressed economic regions of our state by developing a high-tech skilled workforce. Computer science and coding utilize critical thinking and problem-solving talents that benefit all career paths."[9]
- CompTIA's 2022 State of the Tech Workforce report showed that **West Virginia** is among the five states with the lowest concentrations of technology-driven opportunities–indicating it may be a state intending to use CS programs to develop skills for state residents.[10] WV has 1,553 open computing jobs (5.2× the state average demand rate of any other field).[11] In 2019, the state had 198 total CS graduates. The WVDE CS state plan recognizes that these skills are critical in preparing students for any career. "Offering the opportunity to learn computer science is critical for preparing our students to be college and career ready in the 21st century — not just for coding or computing occupations, but for every career. The WVDE will support these opportunities for West Virginia's students to thrive in their home state by enabling every school to offer computer science."[12]

Diversifying the State Tech Workforce

Many states already have a significant technological workforce. In these cases, the states may be driven to achieve greater equity in the workforce by providing opportunities for students to develop CS skills while in high school.

Centering Equity

Although the vision for individual states may be driven by economics, workforce demands or civic engagement, equity is also an important consideration for all CS efforts and permeates every policy decision, resource allocation and implementation choice.

Washington State has infused equity into its CS state strategic plan, guiding all other work. The state plan recognizes that:

> "The result of equitable access should be CS classrooms that are diverse in terms of

race, gender, disability, socioeconomic status, and English language proficiency. WA State seeks to play a significant role in building access to and equity within systems for the implementation of high-quality and inclusive CS education."

The state plan also calls for educational equity by requiring education leaders to critically examine the ways in which policies and practices can result in differentiated outcomes for students. Doing this requires an acknowledgement of historical racism, engagement with families and communities and dismantling systemic barriers while replacing them with equity-based policies and practices)[13].

Ohio does not yet have a state CS requirement, although the State Committee on Computer Science, formed under House Bill 110 of the state operating budget, recommends that "Ohio should require one credit [one full-year class] in computer science for all high school graduates by the end of the decade (2030)."[14] The current standards guiding CS instruction call for equity, noting that "To help realize the vision of computer science for all students, equity must be at the forefront of the state's efforts to implement the computer science standards. Equity is more than whether classes are available. It includes how those classes are taught, how students are recruited and how the classroom culture supports diverse learners and promotes retention."

Defining the Requirement

How CS is included in a high school portfolio varies across states, with requirements depending on policy at the state and local level. There are four models we've identified that support high school students earning CS credits.

Required for graduation:	Seven states have policies that require CS for graduation. This means all students must take CS to receive a high school diploma from the state.
Count toward graduation:	Most states allow CS course credit to count towards fulfilling graduation requirements, often as a unit of core math or science or as a technology credit.
Require all schools to offer CS:	30 states require all high schools in their state to offer a CS course.
Admission into state-run higher education institutions require a CS credit:	State-run higher education system requirements can influence what is offered at the high school level as schools prepare students to progress along an educational pathway.

A variety of contextual factors impact the paths states take toward CS requirements, including how the educational system is organized (local control versus centralized at the state level), the support and priorities of politicians in the state (often influenced by CS advocacy groups), and local workforce and economic demands. Examples of these models are explored below.

Graduation Requirements

The following states have CS graduation requirements.

Arkansas

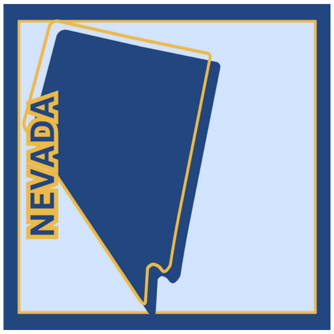
Arkansas was the first state to require all students to have a CS credit in order to graduate. Signed into law in March of 2021, the requirement was implemented in the fall of 2021 with full compliance beginning with the class entering ninth grade in the fall of 2022. To avoid adding credit burden to the graduation requirements, the CS course can count as a 4th math, 3rd science or career-focused requirement. This law was preceded in 2015 with the establishment of a Computer Science and Technology in Public School Task Force, which published a state plan for CS in 2016.[15] Included in the 2015 act (Act 187)[16] was a requirement that each public high school and charter school offer a course in CS. The act was driven by the urgency to meet growing workforce demands.[17]

To date, Arkansas has allocated over 28 million dollars to support CS education. Professional development is provided to teachers at no cost, with tuition waivers available to pre-service teachers licensing in CS.

A later bill which passed in 2023 (SB470)[18] allows students in Arkansas to fulfill the CS requirement by taking a CS-related Career and Technical Education (CTE) course. The Division of Career and Technical Education is now required to work with the Department of Education to establish the minimum criteria by which a CTE course may be approved as a CS or CS-related CTE course.[19] Those who spoke against the change cited the value of CS to all students as a fundamental component of basic education, the importance of developing the state's talent pool for coders and cybersecurity specialists and protecting Arkansas as a leader in the CS education movement.[20] The requirement for each high school to employ a CS-certified teacher was removed.

To date, Arkansas has allocated over 28 million dollars to support CS education. Professional development is provided to teachers at no cost, with tuition waivers available to pre-service teachers licensing in CS.

Nevada



In August of 2019, Nevada created a CS graduation requirement by rebranding the existing half credit (1 semester) "computer literacy" requirement as "computer education and technology" and requiring that CS and computational thinking comprise at least 50% of the course content. The new regulation was fully implemented for the 2019–20 school year and became required for the class graduating in 2023.[21] The course can be taught by any current licensed teacher who has a computer literacy or computer applications endorsement, or a current licensed CTE business teacher or CS teacher (Approved Regulation on the Commission on Professional Standards in Education, 2020). The requirement may also be completed during middle school, provided all relevant standards are met.[22]

Earlier 2017 legislation required all students to "receive instruction" in computer education and technology prior to sixth grade, building the basis for a CS-focused educational pathway.[23] How the elementary requirement is fulfilled is “up to each district or each individual school and their resources - teachers, computers, lab time, etc.”[24] Built into the 2017 statute is an explicit call for school districts to “Make efforts to increase the enrollment in [computer science courses] of female pupils, pupils with disabilities and pupils who belong to ethnic and racial groups that are underrepresented in the field of computer science, as identified by regulation of the State Board.”[25] The need for focusing on female students was identified through an analysis of state data which showed clear and persistent discrepancy in participation. The CS Education Biennium Report demonstrated the immediate effect of the law. In 2015–16, before the law was implemented, girls represented just 22% of students enrolled in CS. In 2018–19, this figure increased to 33%. Similarly, only 21% of high schools in Nevada offered CS in 2015–16 whereas 44% offered it in 2017–18 and 67% offered it in 2018–19 (the first two years of funding).[26]

Built into the 2017 statute is an explicit call for school districts to “Make efforts to increase the enrollment in [computer science courses] of female pupils, pupils with disabilities and pupils who belong to ethnic and racial groups that are underrepresented in the field of computer science, as identified by regulation of the State Board.”

Implementation of the requirements is supported by a state strategic plan produced in 2018.[27] Senate Bill 200 appropriated funding, managed through an Account for Computer Education and Technology in the State General fund (created through SB313),[28] where nearly $4 million was allocated from 2017–21. The account was structured to also accept gifts and grants. In 2021 the law was repealed, thus eliminating requirements for non-competitive grants or applications for larger funding allocations. This created a more equity-focused approach by removing the application burden as funding is now allocated directly through student-centered funding. The CSforNV group, a subgroup of the Nevada STEM Hub, which is itself a project of The Nevada Governor's Office of Science, Innovation and Technology, provides support and resources to students and educators such as PD, updates on licensing endorsement requirements, standards, learning and curriculum resources.[29]

South Carolina

Evaluations conducted by South Carolina’s Joint Task Force on Computer Science and Information Technology in 2016 and the successful implementation of K–8 CS standards in 2017 prompted a reevaluation of South Carolina’s existing CS requirement.[30] While termed “computer science,” the requirement primarily included non-computing courses such as keyboarding. Following the release of CS standards for high school in 2018, the South Carolina Department of Education (SCDE) made regulatory changes and revised the list of courses that would satisfy the state’s computer science graduation requirement to better align with contemporary definitions of CS literacy. The 2019–20 school year was the first year of full implementation of the new requirement.[31] By the 2020–21 school year, the state removed waiver options for districts. According to the SCDE, Code.org, Computer Science Teachers Association (CSTA) and ECEP, in 2019, South Carolina was “the only state in the country with a full year, one credit graduation requirement in computer science.”[32]

The state attributes a significant increase in high schools that teach CS (from 43% in 2017 to 69% in 2018) to the new graduation requirements. By 2022, 95.8% of students in South Carolina attended schools that offered foundational CS. Moreover, Code.org’s 2022 State of Computer Science Report showed that after

South Carolina implemented their updated graduation requirement, graduation rates increased across all racial and ethnic groups tracked by the state. South Carolina is also one of three states that has over 40% participation by women in CS. While the national average for female participation in foundational CS courses is 32%, in South Carolina, that number is forty-seven percent.[33]

Between 2018 and 2024, the South Carolina legislature appropriated $5.9 million for CS programs. This included funding for CS certification and professional learning (H. 4300[34] and H. 4100[35]); educator PD regarding the South Carolina Computer Science and Digital Literacy Standards (H. 4300, H. 5150,[36] and H. 4000[37]) and training new CS and coding teachers in schools across the state (H.4950[38] and H. 3720[39]).

After South Carolina implemented their updated graduation requirement, graduation rates increased across all racial and ethnic groups tracked by the state.

Additionally, the legislature allocated $500,000 to the Artificial Intelligence Pilot for FY22–23 (H. 630)[40] and $3 million for FY23–24.[41] This funding is intended for the SCDE "to develop, pilot, and implement a high school curriculum for high school students in an AI career and technology program. The program will include a four-year sequential pathway that is aligned with two- and four-year college automotive programs and includes teacher training, third-party assessments, and certifications." This pilot project focuses on automotive programs due to the workforce needs and interests of industry stakeholders.

Rhode Island

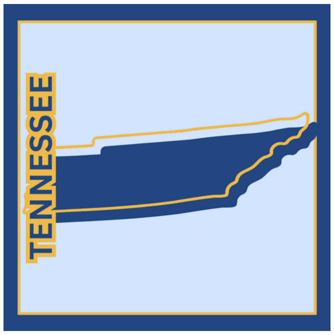
Rhode Island established a CS component to their graduation requirements as part of the 2022 adoption of the Readiness-Based Graduation Requirements. The requirement goes into effect for the class of 2028 and calls for students to meet a "proficiency requirement" in CS. The 2022 requirements replace the existing "technology" requirement with "computer science." "Proficiency" means meeting or exceeding the defined level of knowledge and skills that are established by the standards to award an academic credit".[42] Although the state does have CS content standards for K–12, the Rhode Island Department of Education (RIDE) will engage stakeholders to "adopt standards for each proficiency requirement which will include standards, assessments, and resources to support effective implementation. Local education agencies (LEAs) are recommended to explore the use of flex credits to meet the credit requirements" for CS.[43] Flex credit supports a proficiency-based" learning model by providing "an academic credit that is designed to increase real-world relevant learning for students by providing standards-aligned instruction that incorporates at minimum two (2) subject areas into credit to connected student learning experiences." (200-RICR-20-10-2).[44]

Passing this requirement builds off years of investment and advocacy for computer science in Rhode Island. Since 2017 the state has allocated $210,000 annually for CS PD along with grants focused on Broadening Participation in Computing (BPC) with a priority for Title I-eligible schools. A 2019 grant from the US Department of Education provided $3.5 million to the state to establish CS pathways in RI high schools and study the effect of work-based learning on student CS learning and attitude towards pursuing a CS career.[45] In 2016 Computer Science for Rhode Island (CS4RI) was launched by then-Governor Raimondo. CS4RI is a partnership with the Rhode Island Government, RIDE, K–12 schools, higher education, private industry and nonprofits with the goal of having CS taught in every school in the state. This was particularly ambitious as in 2015 only 1% of RI high school students enrolled in CS courses and only 42 students took the AP-CS A exam. In 2018 RI approved CS education standards across the K–12 pathway based on the national CSTA standards.[46]

CS4RI is a partnership with the Rhode Island Government, RIDE, K–12 schools, higher education, private industry and nonprofits with the goal of having CS taught in every school in the state.

CS4RI reports that by 2022 over 1,500 teachers had participated in PD at no cost to the teacher or districts, and a CS endorsement to the traditional teacher certification was established.[47] Rhode Island lacks a dedicated teacher certification program for CS. Instead, they offer endorsements that enable certified teachers to supplement their existing teaching credentials with CS qualifications. These endorsements are not mandatory for teachers to pursue and are at the discretion of school districts to enforce.[48] Since 2016, over 3,500 students have received University of Rhode Island (URI) transcripted CS credits as concurrent enrollment. The public dashboard shows that 81% of high schools and nearly 62% of middle schools offer stand-alone CS courses. In 2022, 722 students took an AP exam in computing (200 AP CS A and 522 AP CSP).[49]

Tennessee



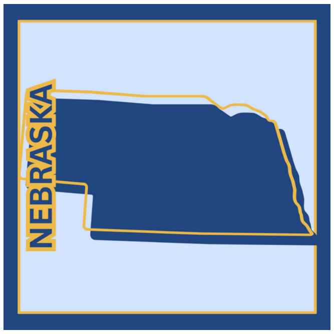
In 2022, Tennessee approved the decision to require a full-year high school CS course for graduation, with the requirement going into effect in the 2024–25 academic year. Additionally, middle school students will also receive one standards-based CS course. House Bill 2153, the bill that created the requirement, was proposed to "ensure that all students are fully prepared for the technological jobs of today and in the future." The bill called for the Tennessee Department of Education (TDOE) to design both an online course available statewide and school-based courses that will satisfy the requirement; to provide PD for teachers, including a micro-credential for teaching CS; and to establish a CS education network to be integrated into the existing TN STEM Innovation Network regional hub system.[50]

Prior to establishing this requirement Tennessee had approved K–8 standards (2018), developed a CS test for teachers (2018), developed a CS plan[51] and presented it to the state legislature (2020) as mandated by Public Chapter No 454, published a set of K–12 standards (2020, revised 2022[52]) and established funding for CS (2021). [53]

In 2021, Tennessee received a $7 million Education Innovation and Research (EIR) grant from the federal Office of Elementary and Secondary Education to "strengthen computer science pathways and STEM education and help more students be prepared for success after high school."

Legislators in Tennessee appropriated nearly $1.3 million in funding for the development of a CS strategic plan, computer science education, teacher professional development, and the implementation of the graduation requirement for fiscal years 22–23,[54] 23–24,[55] and 24–25. Additionally, in 2021, the state received a $7 million Education Innovation and Research (EIR) grant from the federal Office of Elementary and Secondary Education to "strengthen computer science pathways and STEM education and help more students be prepared for success after high school."[56]

Nebraska



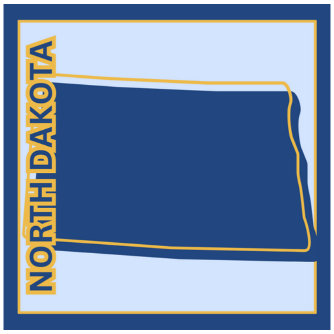
In 2022, Nebraska passed the Computer Science and Technology Education Act (Bill 1112),[57] calling for a one-semester high school CS course as part of the graduation requirements, beginning with the class of 2028 (revised in 2023 via Legislative Bill 705).[58] A CS course, however, is required in each high school in the 2025–26 academic year. This bill is motivated by the desire to develop a strong workforce within the state of Nebraska. These courses can be either in person or online. The state has also commissioned a "Course in a Box" that will provide small districts with resources to support meeting all demands of the legislation. Starting December 1, 2025, the state is also requiring an annual CS and technology status report to monitor student progress. The Act also calls for the adoption of CS standards to be managed under the Math, Science or CTE standards. School districts may choose which courses fulfill the graduation requirement as long as they meet the definition and standards put forth in Statute 79-3303.[59]

In June 2023, Nebraska's governor enacted a bill (LB705A) to appropriate funding in aid of Legislative Bill 705. Though Nebraska does not explicitly dedicate funding for CS programs, Legislative Bill 705 revised CS graduation requirements and funding to support legislation that could potentially be used for CS-focused initiatives. Legislators appropriated $1,032,345 from the FY23–24 General Fund and $1,516,916 from the FY24–25 General Fund to the State Department of Education to carry out the provisions in the bill.

Starting December 1, 2025, the state is also requiring an annual CS and technology status report to monitor student progress.

Additionally, lawmakers appropriated $10 million from the School Safety and Security Fund and $8.5 million from the Education Future Fund for FY23–24 and FY24–25 to the State Department of Education, $18.5 million Cash Funds for state aid, $1 million for the Nebraska Teacher Apprenticeship program, and $5 million for the Nebraska Teacher Recruitment and Retention Act which provides $5,000 retention grants to teachers trained in Nebraska schools after their second and third years of teaching, among other funding provisions.[60]

North Dakota



In 2023 North Dakota passed legislation (HB 1398) creating a CS or cybersecurity high school graduation requirement. Effective after July 31, 2025, this law will also require elementary and middle schools to offer CS courses, including cybersecurity. The requirement articulates that students must take at least one unit of CS or cybersecurity to qualify for graduation. The course can also count as a unit of mathematics or science.[61] The board of a public school or district will need to approve the plan for integrating CS and cybersecurity into their curricula by July 1, 2024, so that they have the flexibility to develop a plan that fits their unique needs.[62] The graduation requirement can be waived if the student has completed a CS and cybersecurity integration plan approved by the school board. Though not well defined in North Dakota statute and policy, other states have used the term "integration plan" to describe a document that describes goals, strategies, key indicators of progress and efficiency improvements.[63] Testimony from North Dakota Superintendent of Public Instruction Kristen Baesler to the Senate Education Committee states that "EduTech will develop template integration plans and a rubric that may be used for evaluating each district's plan. Development of the templates and rubric will occur with input from: ND Department of Public Instruction; The ND CS/Cyber Integration Taskforce; The ND K-20W Working Group; and Other nonprofit K–12 computer science and cybersecurity educational partners."[64] EduTech is funded by the North Dakota legislature to provide IT services and technology PD to K–12 educators in the state.[65]

This work builds upon the PK-20W initiative, which kicked off in 2018, convening stakeholders to develop strategies that empower North Dakotans with the skills they need to find jobs within current and emerging industries in North Dakota. Forty public and private sector organizations participated in the initiative, including the Governor's Office, the North Dakota Department of Public Instruction (NDDPI), TechND and the North Dakota University System.[66] In a 2021 report, initiative members stated that "A comprehensive education in computer science and security fundamentals is crucial to fulfilling the responsibilities of new tech-focused jobs in North Dakota."[67]

This law will also require elementary and middle schools to offer CS courses, including cybersecurity.

Though North Dakota has not explicitly appropriated any funding for CS programs and PD in the state, the 68th legislative assembly state budget actions report for the 2023-25 biennium contained funding for "cybersecurity training, pursuant to HB 1398." Because HB 1398 created the CS and cybersecurity graduation requirement, a requirement for high schools to offer CS and cybersecurity courses, and an adult learning grant program, it is unclear whether that funding was used to support K-12 education. The report contains a fiscal note that the funds would be "used to implement virtual computer science and cybersecurity courses and to provide grants for adult learning.

North Carolina

When North Carolina's Governor Roy Cooper signed SL 2023-132 into law in 2023, North Carolina became the latest state to enact a CS graduation requirement, with the House and Senate passing the legislation with overwhelming bipartisan support.[68] [69] SL 2023-132 creates a high school CS graduation requirement starting as early as the 2024-25 school year. The state has already developed a draft list of courses[70] that satisfy the requirement. The law states that:

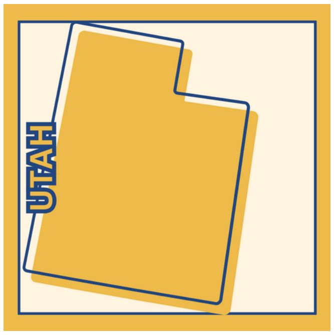
- High school graduation is contingent upon a student obtaining a passing grade in an approved CS course. The requirement would reduce the number of electives by one.
- The Board will not enforce the graduation requirement for students whose individualized education program states that their disability would prevent them from completing the requirement.
- Each public middle school is required to offer an elective introductory CS course (pursuant to the North Carolina Department of Public Instruction [NCDPI] adopting a list of approved courses).
- Each public high school is required to offer a CS course which includes instruction in using existing technologies and creating new technologies. These courses may be offered to middle school students as well.[71]

The North Carolina Department of Public Instruction (NCDPI) and other state agencies cite job growth opportunities as a motivation for the law, stating that computer and mathematical occupations are projected to grow faster than all other industries in North Carolina. In a 2018 report to the General Assembly, NCDPI wrote, "In fact, North Carolina has more than 18,000 unfilled computing jobs with an estimated $1.5 billion in annual salaries available, yet there are fewer than 6,000 students enrolled in CS courses across the state. If we do not equip our students with the proper education and training to fill these jobs, North Carolina will not be able to attract and retain this industry."

North Carolina has more than 18,000 unfilled computing jobs with an estimated $1.5 billion in annual salaries available

To date, North Carolina has allocated approximately $8 million to CS education. The state's FY24–25 budget included $500,000 in non-recurring funds "for K–12 teachers across the State to receive training in computer science."[72]

Utah



While the state of Utah doesn't require CS credits for graduation, it does require students to complete a one-semester half-credit digital studies course. The requirement was designed to "advance students from being computer users to being computationally literate creators".[73] Students can choose from six courses to fulfill the digital studies requirement. Utah did this by replacing the half-credit computer technology requirement and expanding the courses that fulfill the requirement. This change was made in 2016, four years after the Board of Education made its initial recommendation and two years before becoming a graduation requirement. As part of this initiative, Utah designed a modified, one-semester version of the nationally recognized, full-year Exploring Computer Sciences (ECS) course and became the first state in the nation to use this course to meet a high school graduation requirement.[74] In the early implementation stage, the ECS course, one of the favored courses for meeting the digital studies requirement, posed significant challenges for teachers and students, prompting the Utah State Board of Education to overhaul the standards and state skills exam while making substantial investments in teacher support.

In 2019, H.B. 227 established the Computer Science for Utah Grant Program for the purpose of implementing the 2019 Utah Computer Science Master Plan. In addition to the five digital studies courses, 18 courses are considered CS with some of these eligible for fulfilling a math or science credit.[75] The grants are designed to improve "computer science outcomes and course offerings, demonstrated by the creation and implementation of a local agency computer science plan and the effective implementation of approved courses and the provision of effective training opportunities for licensed teachers" H.B. 227 (63N-12-506).[76]

The CS Education Master Plan highlights the importance of including diversity in CS initiatives recognizing that female-identifying students, racial and ethnic minority groups, and people with disabilities are underrepresented in CS classes. The plan proposes partnerships with organizations that offer "unplugged" curricula and modifying validated educational strategies and best practices to meet the needs of students in Utah. It also calls for including parents and counselors in the learning process.[77]

> **Although Utah is still struggling for equitable gender participation (female participation in 2021–2022 was 34.9% compared to 65.1% of males) is equal or outpaces representation on categories of Race (Hispanic, Asian and other/multiple races) those with Economic Disadvantage, Students With Disabilities, and English Language Learners.**[79]

According to a 2019 CS landscape report, half of high school students statewide enroll in ECS, making it the most popular CS course. This includes 44% of female students. The landscape report also found that fewer girls and students with low socioeconomic status took a second, associated, CS course after an introductory course (Computer Programming 1 through Computer Programming 2; Game Development 1 through 2 and Web Development 1 through 2). From 2013–18 the percentage of girls that took a second CS class was 8.3% whereas 13.3% of boys took a second CS class. When examining the data by low socioeconomic status, 7.3% of students take a second CS course.[78] The CS4Utah Dashboard, which has the most recent data available shows that although Utah is still struggling for equitable gender participation (female participation in 2021–2022 was 34.9% compared to 65.1% of males) is equal or outpaces representation on categories of Race (Hispanic, Asian and other/multiple races) those with Economic disadvantage, students with disabilities, and english language learners.[79]

CS Counting For / Towards Graduation

Most states in the US have created mechanisms for CS to count towards graduation, even if they don't specifically require it to graduate. Depending on the degree of local control, individual districts may have more or less flexibility in how they apply the credit.

CS Counting as a Math or Science Credit

Many states allow CS to fulfill either a math or a science credit while some allow CS to fulfill only a math or only a science credit. Usually, a state gives more specific guidance for when this swap may occur. In **Arizona**, for example, districts can choose to allow CS to replace Algebra II as the third math credit.[80] In **Delaware,** CS can count for up to one math or science credit for graduation but may not be counted in place of Algebra 1, Geometry or Biology 1.[81] In **Missouri**, CS can fulfill a math, science or practical arts course.[82] In **Idaho**, AP Computer Science or dual-enrollment credit CS can count as one mathematics (after completion of Algebra II) or up to two science credits for graduation.[83] In **Connecticut**, CS counts towards fulfilling one of the nine STEM credits, beginning with the class of 2023.[84]

> **Massachusetts allows selected CS courses to count as a math or science credit as part of the MassCore program:**
>
> Math (four units required): Students may substitute one unit of CS that includes rigorous mathematical concepts and aligns with the DLCS standards for a mathematics course.
>
> *The minimum admission standards to a 4-year state school include "4 courses (including algebra I and II and geometry or trigonometry, or comparable coursework)* ***including math in senior year.*** *CS courses may be considered a mathematics course based on the inclusion of rigorous mathematical concepts and topics."*
>
> Science (three units required): Students may substitute one unit of CS that includes rigorous scientific concepts and aligns with the DLCS standards for a laboratory science course.

Fulfilling a Technical Education Requirement

In **Maryland,** CS can fulfill the one-credit "Computer Science, Engineering, or Technology Education credit," which most students use a CS class to fill. And, as a result, 95% of Maryland high schools offer CS, one of the highest rates in the nation. In 2022, 37% of graduates statewide took at least one computing course. Eighteen percent of these graduates who went to college declared a CS-related major.[85] Prior to this change, only 4% of students in Baltimore County enrolled in a computing course. By 2022, 100% of high schools in the district offered CS with 30% of students participating in a course. **Virginia** also requires two credits in World Language, Fine Arts, or Career and Technical Education, the latter of which can be fulfilled by an approved CS course.[86]

As seen in **Arkansas**,[87] **Nevada**,[88] and **Nebraska**,[89] some states allow the high school requirement to be fulfilled in middle school if students take a high school-level course. This is distinct from some states and districts that are requiring CS to be taught in middle school in an effort to build a pathway into high school computing programs. Relatedly, many states (including but not limited to **Alabama**,[90] **Iowa**,[91] **Mississippi**,[92] **North Dakota**[93] and **Tennessee**[94]) are also requiring schools to offer CS in middle school, seeking to generate early interest and awareness in the subject.

As exemplified in **South Carolina**, **Utah, Nevada** and **Maryland**, existing technical education requirements were modified to include CS, thereby increasing the rigor of an existing requirement.

In many states, graduation requirements are designed with enough flexibility that districts can require CS or have it count towards fulfilling core graduation requirements even if it is not an expectation statewide.

All Schools Offer CS

As states across the nation move towards expanding access to CS, at least 30 require all schools to offer a CS course.[95] Many of these states are expanding the CS pathway into elementary and middle schools.

CS Credit Required for Admission to a State Institution of Higher Education

Mississippi institutions of higher learning require all students applying for college within the Mississippi state system to have at least one credit of technology or CS. Technology courses emphasize the use of technology for productivity while CS courses emphasize computational thinking to solve problems. This requirement for admission went into effect for students admitted in fall 2023.

In California, the minimum sequence of courses that must be met for consideration to the University of California or California State University includes CS as an option for meeting one of the credits in the math, science, CTE or elective sequence.[96] Although this differs from *requiring* CS for admission to a state institution for higher education, it is an important driver to the K–12 credit structure as 89% of college-going high school graduates from California stay in-state.[97]

Approaching CS From the Earlier Grades

In 2021, Hawai'i passed Act 158 (SB 242),[98] which requires that CS courses or content be offered in at least 50% of elementary and middle schools per complex area (district) by 2023, and in all state elementary and middle schools by 2024–25. (The content may be offered virtually, but there must be an on-site proctor.) Support for this act was based on successful implementation of the 2018 Act 51 (HB 2607),[99] which had successfully expanded access to and participation in computing in Hawaiian high schools.

Though Act 158 was passed with no resources or communications plan included, it deliberately increases equity in access; because students in the early grades do not choose their courses, all students will have early exposure to CS. This has allowed Hawai'i to focus legislatively on K–2 upwards by building their CS education pathway from the start of a student's educational journey. There are concerns, however, with implementation as it assumes all schools are starting from the same place. The data shows that support for computing has been uneven; in some complex areas, there is no CS in the elementary schools whereas 75% of schools offer CS in other complex areas.[100]

The act also explicitly says that 'Ōlelo Hawai'i and English language opportunities for CS will be offered. Hawaii has a system of K–12 Hawaiian language schools ("Kaiapuni schools") where English isn't introduced until Grade 5, which means that all of their elementary CS curriculum has a full Hawaiian translation and implementation.

Act 158 also established a CS education special fund to accept deposits from the state legislature, gifts, donations and grants to be administered by the Hawai'i Department of Education to support PD and CS pathways K–12.

Data reporting is built into Act 158, as it asks for annual reports of the number and percentage of participants enrolled in each CS course disaggregated by gender, race and ethnicity, special education status, English Language Learners, eligibility for free and reduced-price lunch and grade level. Teacher data must also be reported and disaggregated by gender, race, ethnicity, certifications and highest academic degree.

Exemptions For Students Who Transfer from Out of State

As states set new requirements, the timeline for implementation varies from a few months to several years. In some states, exemptions are provided for students moving into the state during high school years. For example, Nevada allows waivers for students who transfer during grade 12, provided they have completed a comparable course at their previous school or successfully complete the required coursework through an alternative means as defined by the district.[101]

Courses That Fulfill the Requirement

There is variation between states as to which courses count towards fulfilling the CS requirement, the duration of the course (semester or full year) and when it can be fulfilled (middle or high school or just in high school). States that require CS vary widely in the number of courses that count towards fulfilling the requirement, ranging from 12 in Rhode Island to 70 in North Carolina. Across the eight states that have an explicit CS requirement, an average of 29 distinct courses meet the requirement per state.

There is general agreement that programming/coding courses and cybersecurity courses meet the requirement. There is less agreement around courses such as Networking and Digital Media Design. Table 1 shows the types of courses included, the number of states that *explicitly include* the course, the number that *explicitly exclude* the course, and the number of states that don't specify if it counts or not. Although courses are mutually exclusive within categories, some categories may overlap. For example, a data science course may be similar to a computer mathematics course.

Table 1: Courses That Fulfill a Graduation Requirement

Course Name	# of states that allow course to fulfill requirement	# of states that don't allow course to fulfill requirement	# of states that don't specify if the course fulfills or not
Programming/Coding	7	-	1
Cybersecurity	6	-	2
Mobile Development	3	-	5
Data Science	3	-	5
Game Development	3	-	5
Robotics	3	-	5
Digital Media/Design	2	-	6
Networking	2	1	5
Python	2	1	5
Swift	1	1	6
Computer Mathematics	0	1	7

Massachusetts currently has an extensive list of courses that include computer science content. However, these are not all considered comprehensive foundational courses in high school. As part of the MassCore program, only four specific courses may be used to count towards a math or science credit:[102]

#10019 Advanced Placement® Computer Science Principles: Advanced Placement® Computer Science Principles is not a single curriculum; rather, schools and organizations submit curricular materials to the College Board for audit to ensure they meet or exceed the College Board's expectations as articulated in the AP® Computer Science Principles Curriculum Framework.[103]

#10011 Computer Science Principles: Based on the AP® Computer Science Principles Curriculum Framework, CSP can be taught as a non- AP® course.

#10012 Exploring Computer Science: Exploring Computer Science is an open source curriculum developed by UCLA and the University of Oregon. Exploring Computer Science was explicitly designed to expand participation in computing by traditionally underrepresented students in terms of enrollment, access, knowledge and skills, problem-solving and attitudes. Exploring Computer Science is pedagogically and conceptually aligned to the AP® Computer Science Principles Curriculum Framework: http://www.exploringcs.org/.[104]

#10090 Computational Thinking and Problem Solving: Computational Thinking and Problem Solving (CTPS) presents computational thinking in the framework of a team-based, workplace-oriented project-based-learning course. CTPS introduces an array of CS and IT competencies through a problem-based approach for students to apply learning in more relevant ways through authentic industry problems. CTPS is pedagogically and conceptually aligned to the AP® Computer Science Principles Curriculum Framework: https://www.csforma.org/computer-science-education/curriculum/ct-ps/[105]

Role of Advocacy Organizations/Organizing the State

Advocating for and creating state CS programs requires partnerships with a diverse set of stakeholders. Many states have adopted partnerships with organizations that help coordinate the efforts in the state, either under the banner of a CSfor[STATE] nonprofit or other academic or nonprofit organizations. These partnerships allow states to implement more sustainable and equitable CS programs because their design and execution includes expertise from stakeholders with varied perspectives.[106] Examples include:

- CodeVA: In 2020, Virginia allocated $1.1 million over two years to CodeVA, a nonprofit dedicated to enhancing CS literacy and bringing teachers together to explore and share knowledge. The nonprofit offers professional learning courses to K–12 educators in Virginia. One project, CS-Ready Schools, which is a collaboration between CodeVA and the Virginia Department of Education (VDOE) through Amazon Future Engineer, seeks to extend CS education for 500,000 students and train over 12,000 teachers, administrators and counselors.[107]
- Washington public-private partnerships: Washington state included recommendations to create public-private partnerships in their strategic plan. The authors stated that a CSTA state director

would engage educators, Teacher Education Programs (TEPs) and private industry to convene a CS professional learning network. Additionally, the CS task force emphasized collaboration with trusted community messengers, like community-based organizations and nonprofits, to "make clear, consistent, and timely messaging about CS opportunities available."[108]

- Nextech Indiana: Indiana's Department of Education contracted with Nextech to deploy teacher PD to educators in the state.[109] Specific duties carried out by Nextech included: participating in the 2022 Summer of Learning conferences and developing English Language Learner and special education CS resource hubs in the Indiana Learning Lab, providing workshops on teacher PD, convening a virtual CS conference and delivering the Counselors for Computing program.[110]

Involving non-governmental partners in the development of CS programs can help states center equity. The Kapor Center's framework for Culturally Responsive Sustaining Computer Science Education, which is referenced in several state CS strategic plans, highlights the need for diverse professionals and role models to provide exposure to CS opportunities and incorporate community cultural assets into CS classrooms. Courses of action that support these goals include partnering with community-based organizations and building relationships with members of local and national tech communities. Including stakeholders with content and context expertise can ensure that policies and programs are inclusive and relevant to the communities they serve.[111]

State agencies are legally restrained from lobbying for policies and programs—creating an opportunity for non-governmental stakeholders to advocate for CS education. In Rhode Island, CS4RI took a leading role in calling for CS programs in the state in the years before the graduation requirement was implemented. Since 2013, Code.org has advocated for an expanded CS presence at the state level. States often point to Code.org resources and involve them in the program development process.

Funding Structure

Importance of Funding

States deploy a variety of measures to ensure CS programs are properly funded. Authors of a Code.org case study emphasized the importance of allocating resources to professional learning and development. Without funding for educators, states cannot equitably implement CS programs.[112]

A consistent theme across state strategic plans is advocacy for funding. A lack of financial resources often serves as a barrier to implementing CS programs and requirements. For example, before 2019, **West Virginia** was not able to grow CS programs because the legislature had not provided dedicated funding for "rigorous computer science professional learning and course support."[113] **Washington** included funding as a strategic goal and added, "WA State will prioritize funding for professional development in CS for existing WA State teachers, while also supporting pre-service teacher CS endorsement pathways. Additionally, funding priority will be given to districts in which a demonstrable effort is made to engage underrepresented groups."[114] **Ohio**'s State Committee on Computer Science went as far as recommending the state allocate 1% of state educational funding (approximately $94 million per year) to CS education.[115]

While some states have a foundation of state funding in place when they create standards and requirements, others deploy funding after programs have already been enacted.

- **Pennsylvania** did not have CS standards in place until 2019 but has invested in training high-quality STEM and CS educators since 2018 through their PASmart grant program.[116]
- **Oklahoma** has programs in place, including K–12 CS academic standards, legislation requiring the Department of Education to develop a rubric for implementing high-quality CS programs, a strategic plan and a requirement for high schools to offer CS courses, but no appropriations. Despite the provision in SB 593 (2019), "Subject to the availability of funds, One Million Dollars ($1,000,000.00) shall be allocated by the State Board of Education to develop and implement high-quality professional learning opportunities for computer science courses that align to the Oklahoma Academic Standards for Computer Science and align to the rubric developed by the State Department of Education for quality computer science programs pursuant to Section 1 of this act," the legislature did not appropriate any funding to the program.[117]
- **North Carolina** has had programs in place since 2015 when they published their digital learning plan, and has provided over $7 million in funding since 2017.

The sustainability of state funding for CS programs varies. Many states use an infusion of grant funding or private dollars to explore new models of teacher PD, curricular or pedagogical practices, or district engagement with the hopes of scaling more widely. Some states make one-time investments in programs that accelerate CS education efforts. Other states have made funding for CS recurring line items in their state budgets. South Carolina, for example, has appropriated $500,000 every year since FY 2020 to fund educator PD regarding CS standards.[118] The Governor has prioritized recurring dollars for CS education in South Carolina, especially through Education Improvement Act funds.[119] Without reliable and predictable funding, state entities may have difficulty launching and sustaining CS programs that make a significant impact. Importantly, funds that go beyond capacity building through teacher or district development or by providing curriculum and technology to schools and districts to develop a supportive infrastructure through the state are also critical to maintaining sustainable CS models.

Distributing Funds

States have used a variety of models to distribute funds:

***Department of Education*.** States often appropriate funding directly to their Department of Education to implement CS programs. For example, **New Hampshire** appropriated funding to the state's Department of Education to encourage educators to pursue credentials in the field of CS, encourage teachers with credentials to teach CS, implement an experiential robotics platform in grades 6–12, and establish a CS and state-level STEM administrator position. **Texas** and **South Carolina** also allocated funding to their Departments of Education/State Education Agency.

Districts and Local Agencies. Some state legislatures choose to invest directly in local entities and districts or appropriate funding to state agencies for allocation to local agencies. Out of $85 million **California** appropriated from their General Fund to the Superintendent of Public Instruction for allocation to county offices of education for PD and engagement, $35 million was earmarked specifically for the Fresno County Office of Education. An additional $15 million was appropriated from the General Fund to the State Department of Education for allocation to one or more local educational agencies "to coordinate and support professional learning opportunities for educators across the state."

Grant Programs. States can appropriate funding for entities within the state (often the state's Department of Education) to administer a grant program. In appropriations language, **California** legislators state, "The State Department of Education shall, through a competitive grant and subject to approval by the executive director of the State Board of Education, select one or more institutions of higher education or nonprofit organizations with expertise in developing and providing professional learning to teachers and paraprofessionals in public schools."

NGO Partners**.** States like **Virginia** appropriated funding to nonprofits for developing and implementing high-quality PD for educators. Virginia's HB 30 (2020) allocated $1.1 million over two years from the general fund to CodeVA, a nonprofit dedicated to enhancing CS literacy and bringing teachers together to explore and share knowledge.[120] While **Indiana** did not provide any direct appropriations to nonprofits in the state, their Department of Education did contract with Nextech to deploy teacher PD. In **Maryland**, the Governor appropriated funds to the Computing Education and Professional Development Fund, which is administered by the Maryland Center for Computing Education (MCCE). The MCCE is housed at the University System of Maryland and was founded in partnership with the University of Maryland, Baltimore County, and the University of Maryland, College Park. Moreover, MCCE collaborates with the National Center for Women in Technology to provide PD to school counselors to support students in course selection and preparation for secondary education.[121]

Private Industry Match. Occasionally, state funding is contingent upon private industry match dollars. For example, **Texas**'s HB 1 (FY24–25) dictates that an additional $2 million in General Revenue allocation to the Higher Education Coordinating Board is contingent upon the Board demonstrating that the state's Computer Science Pipeline is able to raise at least $2 million in gifts and donations.[122]

Federal Funding

Federal funding can bolster state CS programs, and COVID relief funding was especially useful in this way. States have used this funding to both accelerate and sustain CS programs. For example, Oregon used $5 million from the Governor's Emergency Education Relief Fund to implement equity-focused CS programs to ensure students across Oregon have access to CS by the 2027–28 school year. This funding is intended to accelerate existing programs, "which have not yet reached into all the schools or all the diverse communities."[123] State Departments of Education made COVID relief funds available to local educational agencies (LEAs) to support PD, learning supports, devices and connectivity, and additional academic services.[124] LEAs could create plans to use funds to both create new programs or sustain existing ones. In 2021, New York City received $State Departments of Education made COVID relief funds available 7.3M in federal funds to assist with the recovery of the city's school system through the Coronavirus Response and Relief Supplemental Appropriations Act (CRRSA) and American Rescue Plan Act (ARPA). The mayor allocated $122 million of these funds to purchasing additional digital devices and expanding CS.[125]

States also fund CS programs through federal Perkins statute dollars, which Congress appropriates in order for them "to develop more fully the academic knowledge and technical and employability skills of secondary and postsecondary education students who elect to enroll in career and technical education programs and programs of study."[126] Utilizing Perkins funding is dependent on how a given state has defined program eligibility. A 2016 blog post by the U.S. Department of Education stated, "Many states are working creatively and innovatively to utilize CTE pathways and Perkins funds to increase access to and completion of computer science courses."[127] In Maryland's Career and Technical Education Four-Year State Plan (reporting on the federal Strengthening Career and Technical Education for the 21st Century Act/Perkins V) the state calls out K–12 CS standards and the Project Lead the Way (PLTW) Computer Science CTE Program as examples of progress towards expanding CS and IT-related programs.[128]

Building Institutional Capacity

Implementing a CS high school graduation requirement will necessitate significant amounts of institutional capacity at the state and local levels. We have identified several specific areas that will require consideration for any state exploring a CS requirement or even expanding its CS infrastructure.

State Supervisors of CS

For a high school graduation requirement to be effectively administered, some states have placed officials within the Department of Education to supervise and support the CS program. For example, **New Mexico** has two state supervisors; one for K–8 and the other for high school. Depending on the complexity of the requirement and the amount of support schools require, states may need to expand their CS-focused staff. **Arkansas** had a state director of CS supported by seven state-wide CS specialists who served regionally.[129] Currently, **Massachusetts** has one dedicated FTE permanent CS official who is supported by a contractor (whose funding is linked to grants or specific initiatives). Successful implementation will rely on the ability of state and local administrators to work together, navigate layers of regulation and policy, and build long-term relationships focused on student success.

Implementation Support

Many districts have successfully implemented CS in their high schools independently, but most will require significant implementation support. For many, this will require funds provided by or directed by the state. In some models, districts apply for funding, describe what they want to do, and then implement mostly independently. This model has already been followed to some degree in Massachusetts through competitive grants for districts to develop their own implementations. However, this has mostly been done on a voluntary basis by highly motivated districts. Districts that are implementing solely because of a requirement are very likely to need different types or models of support.

Some states partner with a nonprofit or independent organization to provide implementation support while other states fund programs directly through the state or as grants through the DOE. For example, **Indiana** uses NextTech to support the implementation of CS. They are partnering with the IDOE and get funding directly to do this work. NextTech provides PD directly to educators and provides grants to other entities that are eligible to develop high-quality PD programs. In another example, in **Maryland**, MCCE organizes the state funding, provides PD and offers grants.

Additionally, as we confirmed during the Digital Literacy Now (DLN) grant evaluation, each district has a unique mix of existing infrastructure and needs that must be addressed when implementing a CS program. One approach to mitigate this has been to create tiered models for implementation that accommodate different contexts and starting points. **Oklahoma** provides one example of how to accomplish this. Oklahoma has 509 districts that are highly varied and geographically dispersed. The state uses its Programs of Excellence rubrics to guide educational programs throughout the state. The

Bronze, Silver and Gold CS implementation guides provide templates for basic implementation as well as more advanced programs, allowing districts to choose what works for them based on available resources.[130]

Professional Development and Credentialing

Adding a CS graduation requirement would require a massive upscaling of the number of teachers trained to deliver CS content. Training in specific curricula is often sponsored by curriculum providers in multi-day summer workshops. Sometimes these trainings are paid for by a grant (as in the DLN project) or scholarships are available (such as for many Code.org programs), but teachers may need to self-fund their attendance, which may also require travel, lodging and food and child-care for a multi-day workshop far from home. Some states provide additional funds to defray the cost of PD. For example, **Virginia** provides funding to CodeVA to cover the cost of annual PD for teachers. Funding for PD may come out of appropriated funds directly, while In other cases, a state may collaborate with a third party (such as **Oklahoma** does with Bootstrap) to provide the PD.

Many states, including **Massachusetts**, have a pathway for teachers to obtain certification in CS, such as through testing, competency review or both. As states enact CS requirements and programs, the demand for educators who can teach CS grows—necessitating innovative state strategies to meet the demand for high-quality CS education. Historically, one barrier to entry for teachers has been the education and testing required to meet certification, licensure or endorsement standards. According to Code.org, as of 2020, 40% of states required coursework or an exam for teachers to obtain CS certification. While some states have invested in PD for educators, others are pursuing a new strategy to ensure teachers can more easily obtain certification to teach CS by demonstrating competency in one skill at a time: micro-credentialing (sometimes called competency-based credentials). Policies allow teachers to learn and practice skills, receive coaching, and collaborate with other educators to produce a portfolio or other artifact to show that they are proficient.[131] The US Office of Elementary and Secondary Education (OESE) has outlined some of the benefits of micro-credentialing including giving teachers the ability to demonstrate defined skills in the classroom, breaking down complex skills into fundamental pieces and allowing teachers to demonstrate proficiency in each, and increasing access to this training through an online format.[132]

According to Digital Promise, 17 states and the District of Columbia have state-level policies or guidelines supporting micro-credentialing.[133] OESE's Education Innovation and Research (EIR) Program funds state entities and other groups to develop and implement evidence-based initiatives like micro-credentialing to improve student achievement and to evaluate those innovations.[134] One project grantee is a partnership between the Louisiana Department of Education (LDOE), Louisiana State University, Bloomboard, Inc. and RAND Corporation to test micro-credentialing for STEM education in **Louisiana**. The initial pilot included micro-credentials for Discovering Computational Thinking, Exploring the Engineering Design Process, and Developing Technical Reading and Writing Skills, among other skills. Teachers are required to submit portfolio-based assessments to earn each micro-credential after attending a six-week intensive graduate-level training course.[135]

Though they do not have official state-level policies or guidelines in place, **North Carolina** and **South Carolina** are exploring micro-credentialing. The North Carolina Department of Public Instruction states that innovative districts across the state are piloting micro-credentialing to offer digital badges to educators who can demonstrate competency.[136] The SCDE has been hosting a micro-credential academy since 2020. The academy has five focus areas: SC Teaching Standards (SCTS) 4.0 Rubric; Collective

Leadership; Cultivating Leadership; Social Emotional Learning; and Diversity, Equity, and Inclusion.[137]

Curriculum and Counselors

States have the option to prescribe a particular curriculum, provide a menu of acceptable curricula, or allow districts and schools to self-select curricula. Unless there is an existing curriculum guide in place, when districts have a choice, they will need to do their own research to determine which vendors comply with state standards. Massachusetts already has a curriculum guide.[138] Other examples include **Montana's** curriculum guide[139] and **Rhode Island's** curriculum overview.[140]

As stewards for student coursetaking at the high school level, school counselors often need training and support to broaden their own understanding of computing and encourage a more diverse set of students into the field. Massachusetts has had some PD for counselors interested in computing.[141] The National Center for Women and Information Technology's (NCWIT) National Center for Women and Information Technology's (NCWIT) Counselors for Computing materials are also readily available.[142]

Monitoring Implementation

Assessment

Any implementation effort requires ongoing assessment to guarantee that policies are enacted as planned. Assessing the implementation is crucial to ensure that students are receiving equitable access to quality instruction, participating in all courses proportional to their demographics in the state (for example, no disparities in who takes more or less rigorous courses), and that longer term outcomes such as subsequent course taking in CS is equitable. Assessing the implementation is also critical as states often have significant regional variation. By monitoring student outcomes and implementation, modifications can be made to ensure that implementation adheres to the intent of policies.

Dashboards

In addition to internal and local measures of success, many states provide public information to track implementation or outcomes. Several examples can be seen on this page curated by the ECEP Alliance. Currently, Massachusetts reports the number of students taking certain types of courses as well as AP test outcomes. Other states have detailed maps showing the spatial distribution of their programs (RI and WA) or detailed equity information (CT). Dashboards can be particularly useful when trying to understand whether statewide access to and participation in computing courses is equitable. Many of the examples provided through ECEP's webpage, for example, provide breakdowns by sex/race/ethnicity and economic disadvantage.[143]

Massachusetts Context

Academic

Access & Participation

CS participation in Massachusetts does not reflect the student population. In 2021, while 83% of Massachusetts high school students attended a school that offered at least one CS course, only 6.6% were enrolled in such a course. This number was lower among minority and disadvantaged students.[144] Any graduation requirement would, in theory, require the capacity to enroll approximately 25% of high school students per year. This does not account for students who choose to take multiple CS courses during high school.

Teacher Licensure Requirements

The DLCS grades 5–12 subject area Massachusetts Tests for Educator Licensure (MTEL) for DLCS licensure was launched in September of 2021. Over the first two years of the availability of the MTEL, there were 210 teachers licensed for DLCS 5-12 with an 84% pass rate in 2022.[145] In the three years prior to the exam, 359 teachers received a DLCS license for grades 5-12 via a Competency Review process. Many of the MA teachers offering CS are doing so with an out-of-field exception or a legacy Instructional Technology K–12 licensure (CITE). Expanding teacher capacity to meet an increased demand for DLCS instruction will need to be considered moving forward. As of 2023, the Digital Literacy and Computer Science PreK–6 license is available. Candidates may either take the DLCS 5–12 MTEL or complete a Competency Review Process specific to the PreK–6 license.[146]

Policy Initiatives

Massachusetts currently gets credit for eight of the ten Code.org CS policy recommendations, with the two exceptions being that all schools are not required to offer CS and that CS is not currently a graduation requirement.[147] Massachusetts has DLCS standards, DLCS licensure for teachers, public coursetaking profiles and a DLCS curriculum guide mapped to the state's standards.[148]

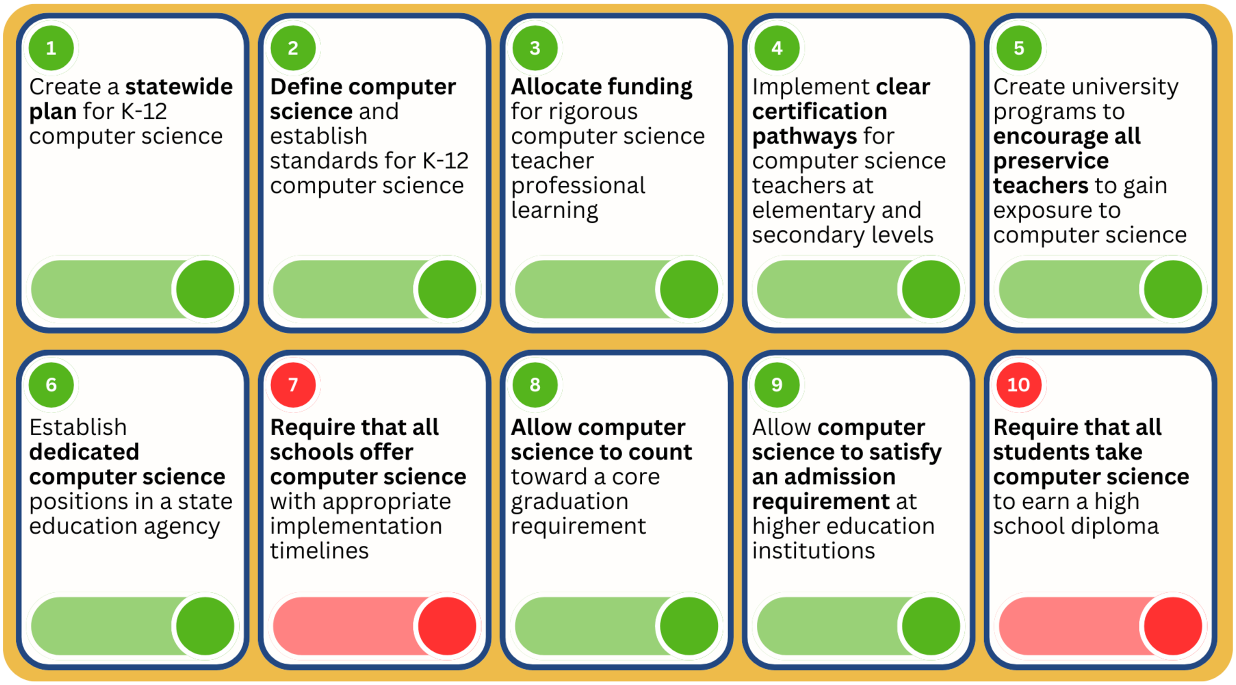


Figure 3: MA progress against Code.org 10 policy recommendations[149]

Graduation Requirements

Any plan to expand public CS education in Massachusetts must take into account both the state's diverse K-12 educational landscape and commitment to local control. School districts in Massachusetts vary widely in size, urban/rural composition, population demographics, family income and local policies. Massachusetts' decentralized education system is designed to ensure that each district has the autonomy necessary to ensure that its unique needs are met. Districts are encouraged, but not required, to follow MassCore graduation recommendations, which lays out a course credit structure to ensure a program of study that meets higher education and workforce expectations.[150] The MassCore recommendation was set forth by the Board of Elementary and Secondary Education (BESE) in 2007 and amended in 2018. Included in MassCore is a provision that allows approved CS courses to count as a math or science credit (with exceptions). Districts must comply with relevant state testing requirements, such as the Massachusetts Comprehensive Assessment System (MCAS).

What's The Difference Between State Graduation Requirements and MassCore?

The MA high school graduation requirements are set by the Massachusetts State Legislature. They include aspects of U.S. history and civics, physical education, and earning a "competency determination" which is defined as passing scores on the Grade 10 English language arts and mathematics MCAS tests and a high school level science and technology/engineering MCAS test.

All other graduation requirements are determined by districts. To support districts, BESE set the MassCore recommendation for a course credit structure to ensure a program of study that meets higher education and workforce expectations.[151] Included in MassCore is a provision that allows approved CS courses to count as a math or science credit (with exceptions). Districts must still comply with relevant state testing requirements, such as the MCAS.

District support for DLCS Implementation

Massachusetts has offered grants to districts to support their DLCS infrastructure, such as the Digital Literacy Now (DLN) grant program and the CS Engage grant. The DLN grant awarded districts up to three years of funding for DLCS visioning, curriculum selection and PD. During the course of the grant, 36 districts participated for at least one year, 393 teachers attended summer curriculum-focused PD sessions, and nearly 25,000 middle school students were in classes taught by DLN-trained teachers. DESE and CSforMA also developed three new PD workshops — one for counselors, one for administrators, and one for teachers new to CS.[152] While the DLN grant focused on grades 6–8 during the initial award year, districts that continued in the program were able to expand to high school and elementary grade levels.

Graduation Rates

Massachusetts has a high rate of graduation across the state with nearly 90% of students graduating in 2021.[153] There are differences, however, by demographic group and region. When considering putting in place a CS graduation requirement, it is important to consider the implications of changing or increasing the demands associated with a diploma for learners who are already struggling to graduate as well as schools struggling to support students on their path to graduation.

Graduation by Demographics

When examining graduation data by subgroup, we see some variation between demographic groups, with English Language Learners, those in Special Education, those with high needs, and Hispanic and Native American students graduating at lower rates than the state average. When we look at multiple identities, we see that graduation rates are even further compromised. For example, in 2021 the four-year high school graduation rate for Hispanic English Language Learners was only 67% (Figures 4 and 5).

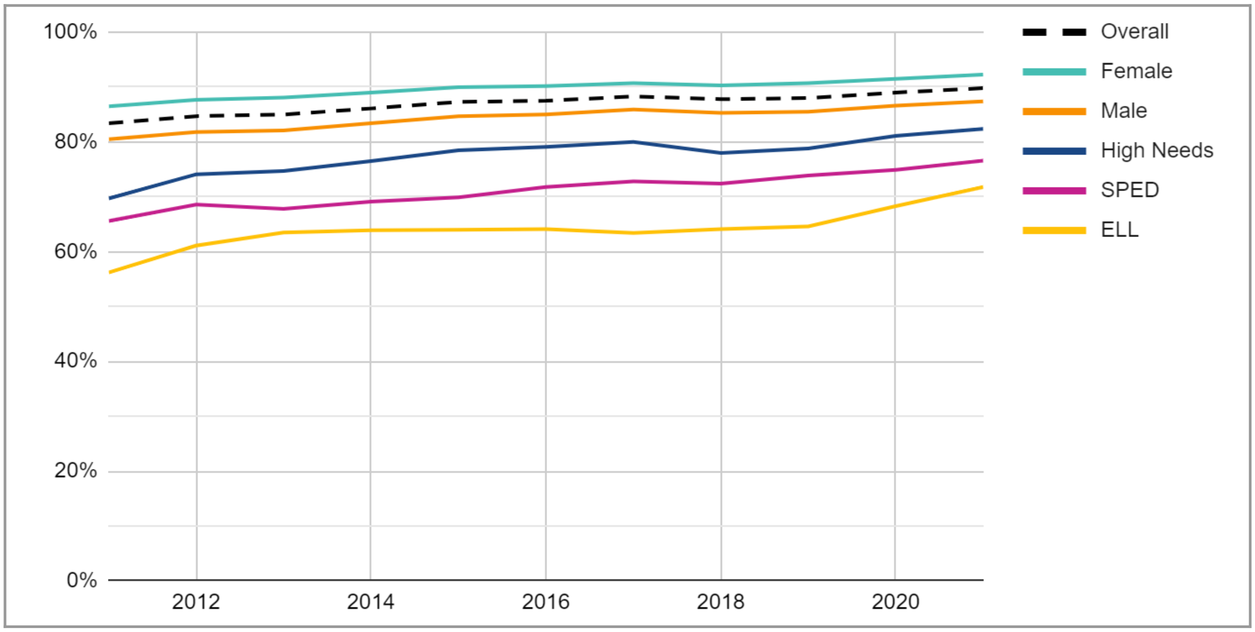


Figure 4: Massachusetts Four-Year High School Graduation Rates by Subgroup

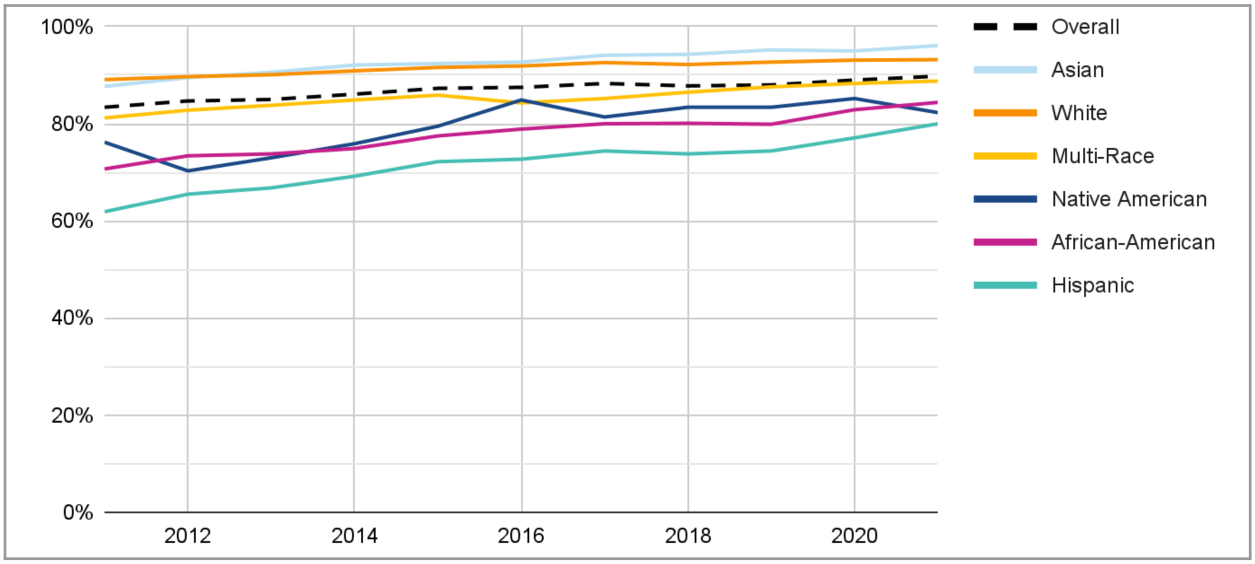


Figure 5: Massachusetts Four-Year High School Graduation Rates by Race / Ethnicity

Graduation Rates by Region

Despite being small, Massachusetts is a diverse state geographically. The graduation rate across regions varies, as does the population growth (Table 2). The more rural parts of the state have seen very little growth while population density is increasing closer to the northeastern part of the state (including cities such as Lowell and Boston), both of which should be considered when setting graduation requirements or creating the implementation support mechanisms.

Table 2: Public high school graduation rates across MA counties[154]

County	High School Graduation Rate 2022	% Population growth 2010–2020
Norfolk	94%	8.2%
Hampshire	93%	2.7%
Nantucket	93%	40.1%
Middlesex	92%	8.6%
Plymouth	92%	7.3%
Worcester	90%	8.0%
Barnstable	90%	6.1%
Berkshire	90%	-1.7%
Bristol	89%	5.6%
Essex	89%	9.0%
Hampden	88%	0.5%
Franklin	85%	-0.5%
Dukes	84%	24.6%
Suffolk	80%	10.5%

Higher Education

Massachusetts has a well-educated youth population. By March of 2022, nearly 63% of Massachusetts' 2021 high school graduates had enrolled in a two- or four-year college (11.3% and 51.3% respectively). This is similar to the national average in which nearly 62% of 2021 graduates enrolled in higher education by October of 2021. Nationally, however, a greater proportion of students enrolled in two-year programs than in MA (18.5% in two-year programs and 43.4% in four-year programs). These local and national numbers are lower than seen in the prior years, likely due to the pandemic (see Figure 6). For example, in 2017, 73.6% of students in MA enrolled in a college program compared to 66.8% nationally.

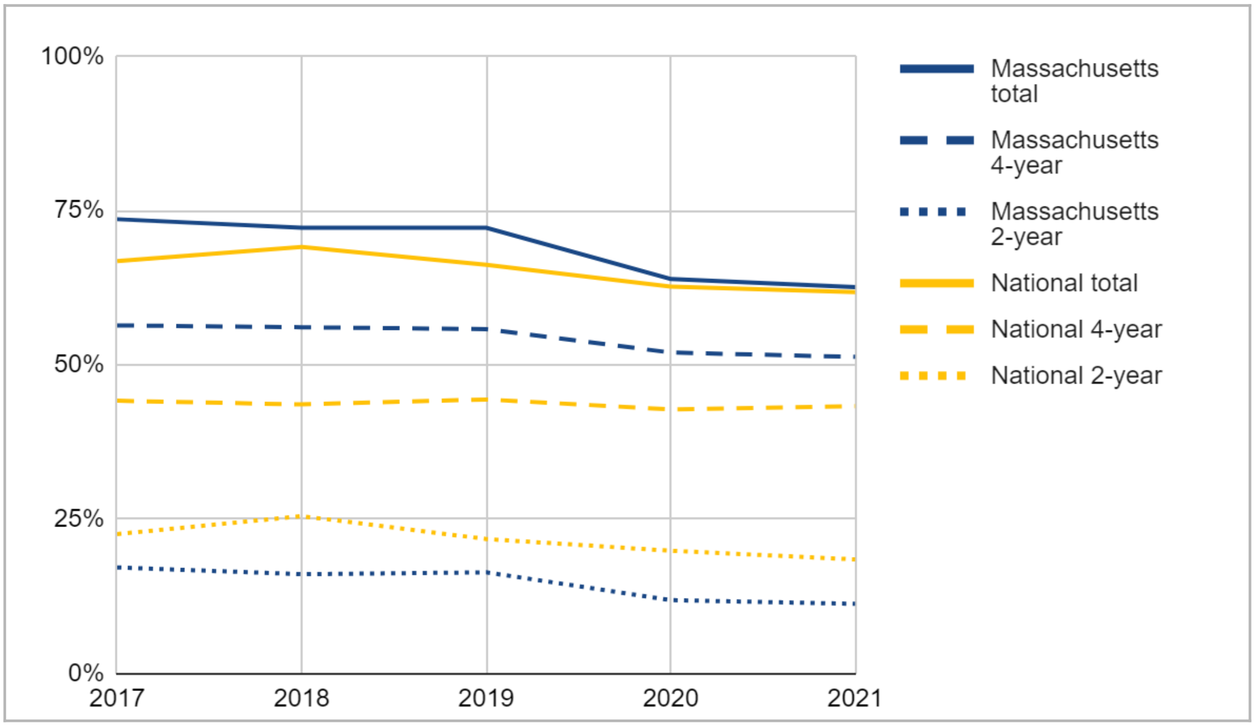


Figure 6: Percentage of Recent High School Graduates Enrolling in Higher Ed by Year[155]

These overall enrollment rates mask some disparities between demographic groups. In Figure 7 we see differences between students in Massachusetts based on gender, where women are enrolling at a higher rate than the general population, as are Asian and white students. Black and Hispanic students are enrolling at lower rates, however, and appear to have been more greatly impacted by the pandemic.

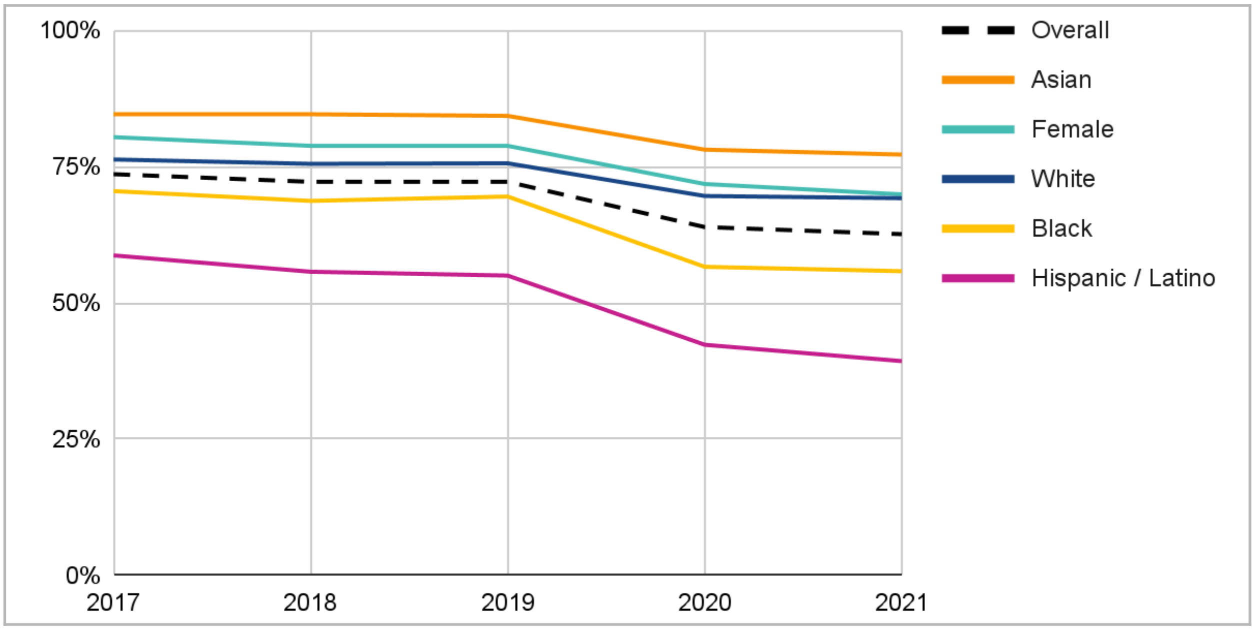


Figure 7: Percentage of MA High Schoolers Enrolled in Higher Ed by March Following Graduation (by Class Year)

With such overall high rates of college-going students in Massachusetts, preparing them for success in higher education is critical. However, understanding the disparities between demographic groups is important when considering the implications of CS education for MA students.

Workforce

Massachusetts has one of the most robust technology-based economies in the nation with significant pharmaceutical, life insurance and education sectors. According to the *State of the Tech Workforce* produced by CompTIA report[156] Massachusetts ranks among the top states for tech employment opportunities and earnings, as 21% of the total Massachusetts workforce is employed by a STEM industry. This is higher than the nation's average of fourteen percent.[157]

Population

Demographics

The population of Massachusetts is also changing. As Figure 8 shows, the overall number of people living in Massachusetts has grown by nearly a half million people over the last decade. This growth is driven by the Latino and mixed-race communities with a decrease in white residents.

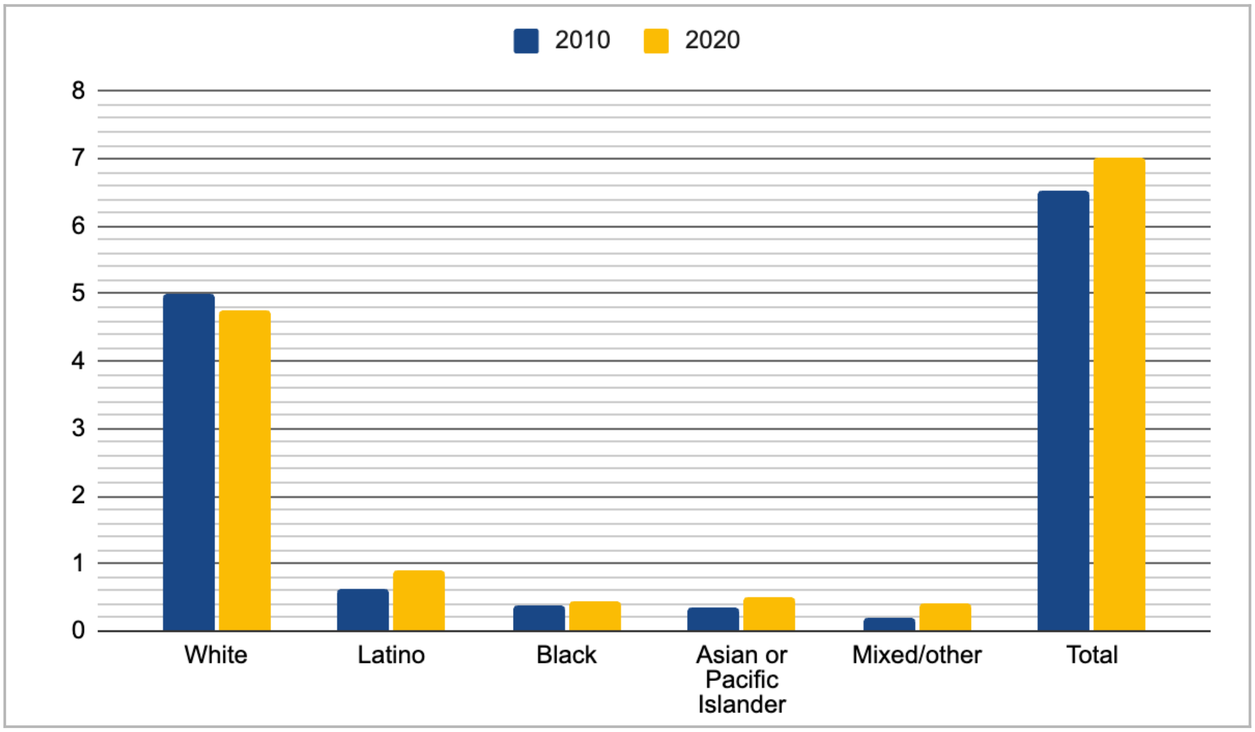


Figure 8: Massachusetts population by race/ethnicity in 2010 and 2020 (millions)[158]

Looking at the patterns of population change against the patterns of graduation rates and higher education enrollments further reinforces the imperative for educational equity when considering a CS graduation requirement.

Prior Investment in State CS Financial Infrastructure

In MA, there has been a long history of sporadic investment in CS initiatives, spanning grants from state and federal sources as well as one-time infusions of money from the legislature with varying requirements and foci:

- Capacity building began in higher education under a Performance Improvement Program grant awarded to the University of Massachusetts Amherst in 2000, entitled the Commonwealth Information Technology Initiative (CITI), to address gaps in CS at local UMass, state and community college campuses across the Commonwealth.
- UMass Boston also received more targeted funding from NSF for the Boston Area Advanced Technological Education Center (BATEC) in 2003 to build seamless computing pathways from Greater Boston high schools to their respective community colleges and into the university system.
- This led to a partnership known as the Commonwealth Alliance for Information Technology Education (CAITE), headquartered at UMass Amherst, which secured NSF funding in 2007 as a Broadening Participation in Computing Alliance focused on addressing CS and Information Technology education and pipeline issues in the state.
- Both the BATEC and CAITE initiatives later moved to the national stage through additional federal funding, leaving a void in direct local work.

In an effort to build a more statewide infrastructure, the Massachusetts Computing Attainment Network (MassCAN) was founded in 2013 as a public-private coalition of education, industry, nonprofit and academic partners who shared a common interest in transforming CS education in Massachusetts. In 2015, the Massachusetts legislature approved funding for MassCAN which required a 1-1 funding match from private corporations with the goal of teaching CS in schools. During its tenure, MassCAN facilitated the development of DLCS Standards (2016) and Licensure (2018) as well as developed some early resources for building capacity. After not being able to meet the corporate match funding required to release the additional state funding, MassCAN suspended operations in mid-2019.

Since 2017 over $20 million in federal funding through the CS for All program has gone through organizations in the state of Massachusetts to support equitable CS research and implementation.[159] [160] Much of this funding went to supporting districts as they developed strategic plans for implementing CS in middle and elementary schools.

The MA Legislature has subsequently provided two one-time funding allocations (in 2020 and 2022), both of which flowed to the Department of Elementary and Secondary Education. These allocations resulted in approximately 45 districts (about 11% of the districts in the state) receiving assistance to develop and implement CS in their districts including planning for student recruitment, teacher development and course curriculum and sequencing.[161] Though multiple rounds of funding were possible, only seven districts received three years of support. Twenty-five districts received just one year of funding, limiting the potential for systemic impact. Additionally, the size (small and rural vs. large and complex) and infrastructure (other grant funding, CS positions) within a district can influence the potential impact of the grant.

Each Massachusetts CS funding initiative has had specific goals and objectives that morphed over time and did not contribute to consistent, systematic, wholesale state change. Further, public/private match programs such as MassCAN, were not sustainable. Our research on other states has shown that sustainable funding can support the implementation of a long-term strategic vision.

Considerations And Next Steps

This report was commissioned by the Massachusetts Department of Elementary and Secondary Education as the first part of a two-phase study designed to explore the opportunities and implications of pursuing a foundational CS course as a high school graduation requirement in the state. This landscape scan will hopefully support states to better understand the variety of ways other states have designed and implemented CS graduation requirements. At this point, most of the implementation efforts are too new to have clear outcomes. In addition, not enough data exists to understand what the unintended outcomes of implementing CS graduation requirements are in relation to:

- the opportunity cost of adding a new course requirement
- potential issues in the quality of instruction
- whether there are enough well-prepared teachers
- implications for equity and
- if the goals of preparing students for subsequent course taking, college and career pathways, or general computer literacy are being met.

Considerations for Massachusetts

Learning from the states that have already enacted CS graduation requirements will help inform the options for Massachusetts. For example, Massachusetts can only create a true requirement if it is legislatively mandated. But similar to Rhode Island, there is the option to embed CS into the MassCore credit structure. Although it isn't a mandate, it is recommended as a comprehensive high school approach with 83% of students in the state completing the recommended MassCore program.[162] In this case, how CS fulfills a math or science credit could be reimagined; or CS could replace one of the five elective courses.

In any scenario, the state should be explicit about equity. Without clear definitions and expectations including reporting requirements, districts will likely flounder in achieving equity.

Finally, the capacity to teach CS should be considered. Currently, 85% of high schools offer CS but only 6% of students take a CS course. It is unclear if these are unique students or perhaps students taking multiple CS credits. To reach the capacity to serve approximately 25% of students per year, additional well-qualified teachers with robust curriculum will be needed. The realities of implementation need to be carefully considered as part of the plan.

Appendices

Appendix A: Authors

This report was created as a partnership between SageFox Consulting Group and CSforMA.

SageFox Consulting Group is a woman-owned research and evaluation firm based in Massachusetts and focused on STEM education across the learning lifespan. For the last fifteen years, SageFox has been deeply involved in the computing education movement in K–12 and higher education locally, nationally and internationally. The firm maintains a specific focus on equity in the development of political and resource capacity for offering computing, considering who has access to computing education opportunities, who participates and how these experiences may vary across groups. Rebecca Zarch, Amanda Menier and Talia Goldwasser (with support from Alan Peterfreund, Mika Hurd and Mike Chery-Winder) contributed to the report.[163]

CSforMA, Inc. is a 501(c)(3) nonprofit and an approved PD provider with DESE for DLCS. The organization serves as the Massachusetts Computer Science Education Hub and functions as an action/research laboratory dedicated to ensuring that all K–12 students have access to, are able to take, and can be successful in high-quality CS coursework.[164] In addition to being the “go to” DLCS PD hub for educators across the state, CSforMA, Inc. has published a Career Data Analysis for entry- to mid-level computing opportunities. Executive Director Deborah Boisvert and Deputy Director Shaileen Crawford supported this work.[165]

Sabah Bhatnagar, Policy Research Consultant, contributed to the research, analysis and writing of this report.

Appendix B: Methods

SageFox’s approach to conducting the state landscape scan focused on our variables of interest in each state. We looked at a wide range of resources, both primary and secondary, including state Department of Education/Education Agency websites, task force reports, legislation, reviews from state non-governmental organizations, federal agency reports, news articles, state laws and CS standards, graduation requirements and course lists, and other resources. Our objective was to surface the current status of laws, programs and standards at the state level, in addition to identifying gaps and opportunities that can serve as models for Massachusetts. Variables of interest for each state included:

- CS graduation requirements
- Whether CS counted towards an existing graduation requirement
- Timeline for implementation of state CS programs, standards and requirements
- State CS standards and how they were created
- Whether the state has a centralized or decentralized education system
- CTE requirements and relationship to CS
- State-level definitions of CS

- Funding for CS programs (both federal and state)
- Teacher licensure and PD
- CS curricula
- Assessment of CS programs and requirements in states
- Stated motivations for creating CS programs and requirements
- Equity-focused motivations and programs relating to CS

Caveats

Though SageFox conducted a thorough review of the landscape, it cannot be considered comprehensive. CS education policy is a complex and emerging area. States vary widely in terms of vision, educational policy context including how and where decisions are made (local control vs. highly centralized educational systems), political support and resources. Our review of available data was thorough but relies primarily on public and published sources which may not cover the full history and effort within each state.

The field is also rapidly changing, and the currency of documents may influence our interpretation of findings. Documents spanned the pre- and post-Covid era, may lag in publication or data currency and may not account for other policy initiatives and/or fully address complementary initiatives within a state. Thus some recommendations or lessons learned may not be comparable across the literature base or in our current economic climate.

Additionally, much available information has been aggregated by third-party organizations and may be missing some of the precise history of each individual state.

Appendix C: Acronym List

ADE – Arkansas Department of Education

AP-CS – Advanced Placement Computer Science

ARPA — American Rescue Plan Act

BESE – Board of Elementary and Secondary Education

BPC — Broadening Participation in Computing

CAITE – Commonwealth Alliance for Information Technology Education

CITI – Commonwealth Information Technology Initiative

CRRSA — Coronavirus Response and Relief Supplemental Appropriations Act

CS — Computer Science

CS4RI — Computer Science for Rhode Island

CSEd — Computer Science Education

CSforNV – Computer Science for Nevada

CSTA — Computer Science Teachers Association

CTE — Career and Technical Education

DESE — Massachusetts Department of Elementary and Secondary Education

DLCS — DESE Digital Literacy and Computer Science

DLN — Digital Literacy Now

ECEP — Expanding Computing Education Pathways

ECS — Exploring Computer Science

EIR — Education Innovation and Research

FTE – Full Time Employee

IDOE – Indiana Department of Education

LEA — Local Education Agency

LDOE – Louisiana Department of Education

MassCan – Massachusetts Computing Attainment Network

MCAS — Massachusetts Comprehensive

Assessment System

MCCE — Maryland Center for Computing Education

MTEL – Massachusetts Tests for Educator Licensure

NCDPI — North Carolina Department of Public Instruction

NCWIT — National Center for Women and Information Technology

NDDPI — North Dakota Department of Public Instruction

NGO — Non Governmental Organization

NSF – National Science Foundation

OESE — Office of Elementary and Secondary Education

PD — Professional Development

PLTW – Project Lead The Way

RIDE – Rhode Island Department of Education

SBAC – Smarter Balanced Assessment

SCDE – South Carolina Department of Education

SCTS — South Carolina Teaching Standards

STEM — Science, Technology, Engineering, and Math

TEP — Teacher Education Programs

URI – University of Rhode Island

WVDE — West Virginia Department of Education

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