2019 Digital Literacy Now 3 Year Plan

Chapter 41 of the Acts of 2019, line-item 7010-1202
Digital Literacy Now 3 Year Plan
December 2019

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Commissioner

April 27, 2020

Dear Members of the General Court:

I am pleased to submit this Report to the Legislature: 2019 Digital Literacy Now 3 Year Plan. The following report was developed by Massachusetts Association of School Superintendents (MASS) and the Department of Elementary and Secondary Education (DESE) and informed by the work and 10-year plan developed by the Massachusetts Expanding Computing Educational Pathway advisory council and stakeholder coalition.

If you have any questions about this report, please feel free to contact Anne DeMallie, the Digital Literacy and Computer Science Lead, in the Center for Instructional Support at ademallie@doe.mass.edu or at 781-338-3527.

Sincerely,

Jeffrey C. Riley
Commissioner of Elementary and Secondary Education

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Introduction

The Department of Elementary and Secondary Education respectfully submits this Report to the Legislature: 2019 Digital Literacy Now 3 Year Plan pursuant to Chapter 41 of the Acts of 2019, line item 7010-1202:

> *"For the implementation of the Massachusetts Digital Literacy Now grant program to establish and promote digital literacy and computer science education in public schools in kindergarten through grade 12; provided, that the department shall develop an implementation plan for promoting technology and digital literacy efforts in partnership with the Massachusetts Association of School Superintendents, Inc.; provided further, that the plan shall consider technology and computer usage and access in low-income, urban, suburban and rural communities; and provided further, that a report shall be filed not later than December 31, 2019 with the chairs of the house and senate committees on ways and means and the house and senate chairs of the joint committee on education that includes a 3-year strategic plan, annual goals and progress in achieving those goals."*

Careers across all industry sectors now and in the future require computing knowledge and skills. And in recognition of that, it is important to address gaps in our education and workforce development system: most students in Massachusetts do not have access to computing education; Massachusetts is not generating enough college graduates with computer science skills to meet the needs of the state's employers; there are not nearly enough teachers with the ability to teach computing; and, there is a dramatic underrepresentation of females, students of color, and other underserved groups in computing fields. The underlying data representing these benchmarks can be found in DESE's June 2018 ***Access to Computer Science Courses in Massachusetts*** report which is included as Appendix A.

Massachusetts is a member of the Expanding Computing Education Pathway (ECEP) Alliance, a National Science Foundation funded program. ECEP is a 23-state alliance for sharing pathways to success in broadening participation in computing. Over the past year, the Massachusetts ECEP advisory council has been convening a coalition of computing education stakeholders to develop a 10-year plan for working collaboratively across the state on strategies that can close the identified gaps with the end objective to have ALL Massachusetts students, college and career ready.

Goals:

- Ensuring that all students – with a focus on females, students of color, and other underserved populations – receive high-quality and standards aligned digital literacy and computer science instruction.
- Aligning coursework and computing pathways that are regionally relevant, advanced in content and pedagogy, and based in Massachusetts's Digital Literacy and Computer Science standards.
- Providing professional development experiences for educators (pre-service and in-service) so they can gain licensure, knowledge, and skills to deliver equitable, standards-

based instruction in digital literacy and computer science that prepares students for college and career success.
- Connecting with and mobilizing a diverse set of stakeholders to promote mutually-beneficial partnerships in support of programs and policies that provide all students with access to standards-based K-12 digital literacy and computer science education.

To achieve these goals, the Massachusetts ECEP advisory council is focusing its efforts in six strategy areas:
- District Engagement
- Curriculum and Computing Pathways
- Professional Development and Licensure
- Collaboration and Communication
- Work Based Learning/Capstone Projects
- DLCS Dashboard

The funding through line item #7010-1202 in the state's FY 20 General Appropriations Act will address all four goals through several of these focus strategy areas.

Digital Literacy Now Grant Program

The following program was developed by Massachusetts Association of School Superintendents (MASS) and the Department of Elementary and Secondary Education (DESE) and informed by the work and 10-year plan developed by the MA ECEP advisory council and stakeholder coalition. MASS and DESE plan to meet regularly to monitor the progress of the program and set priorities and focus for future grants. DESE will be responsible for program administration.

The primary purpose of the Digital Literacy Now program is to establish/expand and promote digital literacy and computer science education in public schools throughout Massachusetts. The program has several parts: district level competitive grants, curricula evaluator, district/professional development/data coordinator, and administrative support for an MA ECEP advisory council for state level work.

District Level Competitive Grants

The purpose of this new state competitive grant is to establish and promote rigorous, engaging, and standards aligned digital literacy and computer science education in public schools in kindergarten through grade 12. These grants are targeted at the district level as the districts are be responsible for creating rigorous, inclusive, and sustainable K-12 digital literacy and computer science education. Priority will be given to districts that support students that are most underserved (including, but not limited to, students designated as economically disadvantaged, English language learners, special education, underrepresented minorities, and living in rural areas).

Goal 1:
Ensuring that all students – with a focus on females, students of color, and other underserved populations – receive high-quality and standards aligned digital literacy and computer science instruction.

This is planned as a 3-year grant cycle. Pending state funding, if the districts meet their plan goals and grant requirements, they will be asked to submit a continuation proposal for a second and third year.

Through this grant, district teams of district administrators, building administrators, and educators will engage in an in-depth, facilitated process to develop a Digital Literacy and Computer Science (DLCS) K-12 implementation plan for their district, select the DLCS curricula to be used within the district, select educators that will deliver the identified DLCS course(s), and ensure that those educators and coaches complete DLCS Professional Development (PD) in order to implement the coursework across the district in Fall 2021.

The first cohort of this grant will focus on middle grades (6-8) DLCS implementation. We expect to be able to fund about 30 districts.

As with all large DESE grant programs, an outside grant evaluator will be contracted to provide program evaluation and reporting.

Grant support, assuming level funding:

Grant support, assuming level funding:

	2020 Year 1	2020-2021 Year 2	2021-2022 Year 3
Number of New Districts	30	15	15
Implementation Planning: 6 day workshop	X		
Implementation Planning Review: 2 day workshop		X	X
Curricular Professional development: ~5 educators per district for the first 2 years and then on a space available basis for year 3.	~150	~225	~225
Annual Convening	X	X	X
Technical Support: curricular implementation and grant reporting support.	X	X	X
Grant Evaluation and Reporting	X	X	X

Three Year Plan

This grant program can support about 30 Districts as Cohort 1, in year 1, 2020, with continued support and professional development in year 2 and support only in year 3. The grant will support professional development for up to 5 educators from each district for a total of 150 educators. Districts will be able to add additional educators if slots are available.

In year 2, 2020-2021, under current funding levels, the program can support the addition of approximately 15 new districts as Cohort 2 with continued support and professional development in their second year and support only in their third year. The grant will support professional development for up to 5 educators from each district in Cohorts 1 and 2 for a total of 225 educators. Districts will be able to add additional educators if slots are available.

In year 3, 2021-2022, under current funding levels, the program can support the addition of approximately 15 new districts as Cohort 3 with continued support and professional development in their second year and support only in their third year. The grant will support professional development for up to 5 educators from each district in Cohorts 2 and 3 for a total of 150 educators. Districts will be able to add additional educators if slots are available.

In subsequent years, under current funding levels, the program can support the addition of approximately 15 new districts. The grant will support professional development for up to 5 educators from each district in their first and second year of the grant for a total of 150 educators. And the grant can provide support to districts in all three years of the grant. Districts will be able to add additional educators if slots are available.

There will also be a yearly convening of the grantees open to all districts to share work and best practices. Timeline presented in Figure 1.

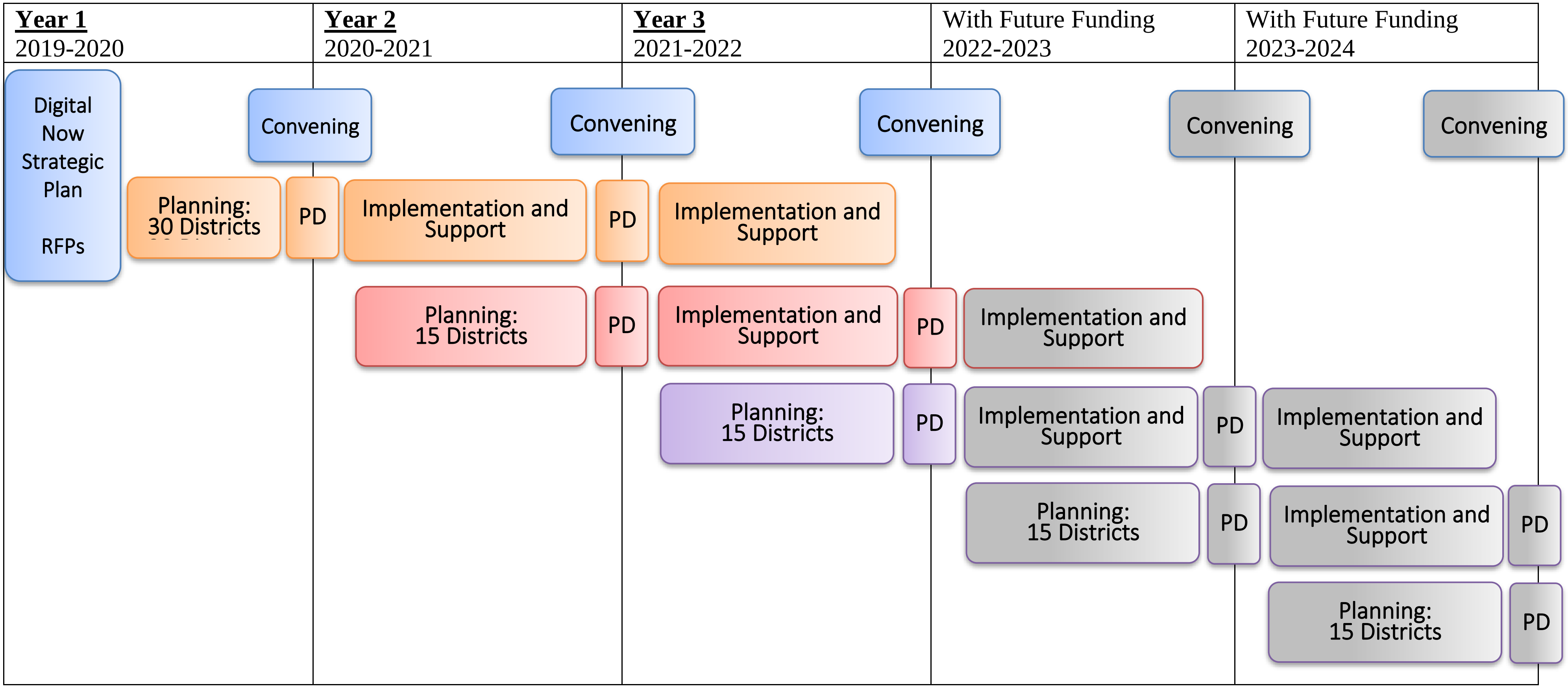


Figure 1: 3 Year Plan Level Funding

Curricula Evaluator

Digital literacy and computer science courses have been taught in some districts for several decades; this is not an entirely new discipline. However with the adoption of the 2016 MA Digital Literacy and Computer Science Curriculum Framework, districts that have been teaching DLCS courses for decades now have to re-evaluate those curricula for alignment with the standards to determine coverage and gaps. On the other side, districts who have not previously offered DLCS courses and are looking to add course offerings to address the DLCS Framework are faced with a plethora of curricula that can often be confusing as to scope and breadth. Cross-walking curricula to the DLCS standards will help districts on both sides make informed decisions. To that end, this use of funds will provide funds to contract a curriculum evaluator that will review and curate a menu of standards aligned, rigorous, high quality, curricula in each grade band with a focus on robust vertical progression. In addition, there will be an explicit request to identify free- or low-cost curricula options in each grade band within the menu.

Goal 2:
Aligning coursework and computing pathways that are regionally relevant, advanced in content and pedagogy, and based in Massachusetts' Digital Literacy and Computer Science standards.

Coordination of District, Professional Development, and Data

This use of funds will provide funds to contract for a District, Professional Development, and Data Coordinator. This coordinator will schedule and facilitate regional district implementation planning workshops and meetings, work with districts in selecting and acquiring curricula for implementation; schedule regional professional development for educators and coaches, provide regular communication (website, social media, and email); provide districts with implementation technical assistance; plan and coordinate a yearly convening of participating and prospective districts; and provide analysis and reporting on progress.

Goal 3:
Providing professional development experiences for educators (pre-service and in-service) so they can gain licensure, knowledge, and skills to deliver equitable, standards-based instruction in digital literacy and computer science that prepares students for college and career success.

Support for State Level Work

Use of funds will provide for a part-time DESE project coordinator to support the administration of this program. As part of this person's duties they will also be responsible for administrative duties associated with the ECEP Advisory Council to continue the state level work in expanding computing educational pathways. DESE participation in the Advisory Council has helped inform the design of this program. The Advisory Council consists of a broad range of computing education stakeholders from K-12 and higher education, business and professional organizations, non-profit and community-based organizations, and policy leadership that have coalesced through our state's participation

Goal 4:
Connecting with and mobilizing a diverse set of stakeholders to promote mutually-beneficial partnerships in support of programs and policies that provide all students with access

in the ECEP Alliance. It is designed to collate the multiple perspectives of these thought-leaders in order to catalyze change in computing education and public-private sector collaboration within our state. The part-time DESE project coordinator will maintain communication between DESE and the Advisory Council between meetings and manage meeting logistics.

Program Needs

This program will engage about 170 administrators and teachers in intensive professional development in year 1 , 2020, and grow in year two and three. Professional Development for these dedicated educators would best be scheduled over the summer months. It is requested that the state funds be allowed to carry over from year to year to allow for that continuity.

Program Expansion

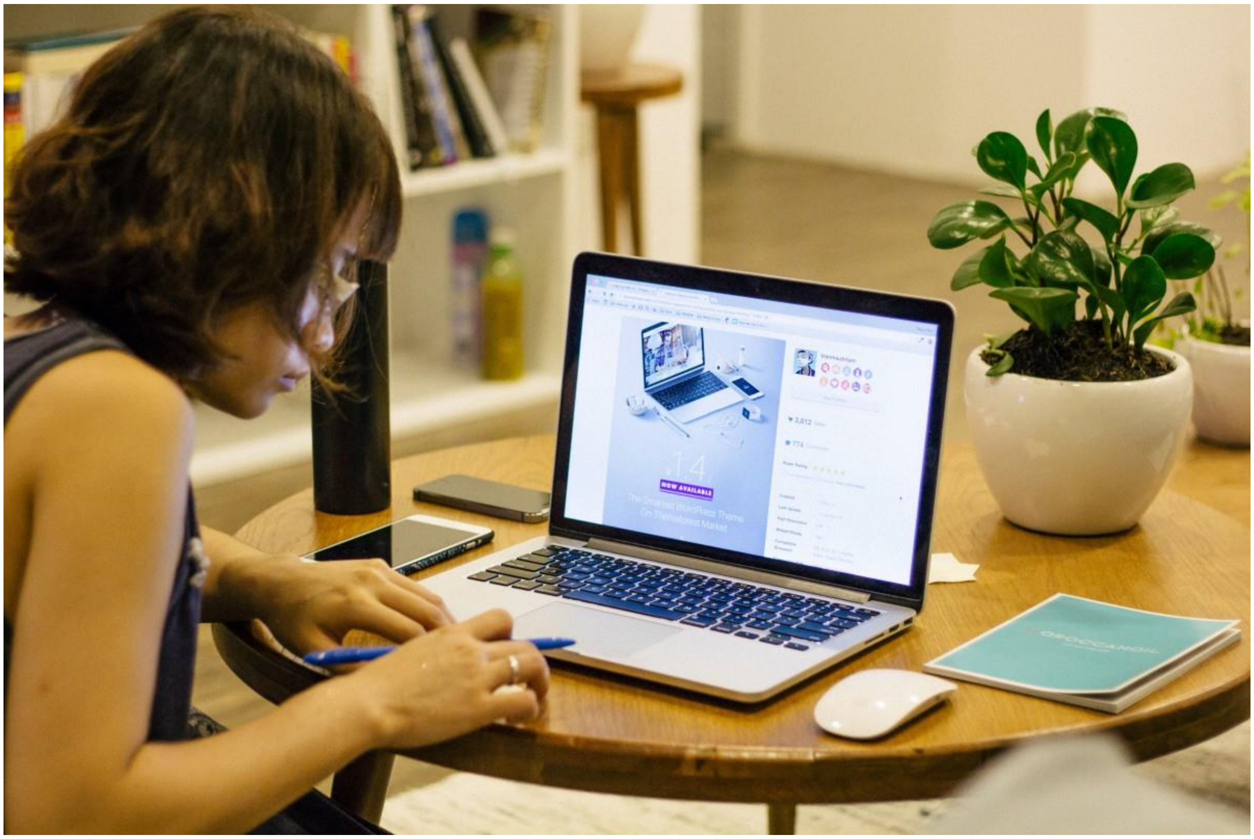
Massachusetts currently has 406 operating school districts. Data analyzed in the June 2018 ***Access to Computer Science Courses in Massachusetts*** (Appendix A) shows that less than half of all districts' elementary and middle grade offer any digital literacy or computer science courses. Additionally, the average course in K-12 covers just 14.5 percent of the Massachusetts Digital Literacy and Computer Science Standards.

In order to achieve the Digital Literacy Now program goal of establishing and promoting rigorous, engaging, and standards aligned digital literacy and computer science education in public schools in kindergarten through grade 12, districts across the Commonwealth will need support.

The state appropriation for this work in FY 20 is $1M, which supports 30 Districts as Cohort 1, in year 1, 2020, with continued support and professional development in year 2 and support only in year 3. Any additional appropriation will increase the number of districts and educators who are able to participate in the program.

Appendix A:
Access to PK-12 Computer Science Courses in Massachusetts

June 2018



Access to PK-12 Computer Science Courses in Massachusetts, 2016-2017

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Executive Summary

This report provides information for designing a strategy to enable students to study and succeed in computer science (CS) in Massachusetts schools[1], particularly students of color, female students, low-income students, students with disabilities, and English learners. The report includes three sections:

- Definitions and data
- Computer science course taking patterns and student access, 2016-2017[2]
- Recommendations for expanding access and studying results

Computer science knowledge and skills are foundational for a well-rounded education in the twenty-first century. Whether students decide to become full-fledged computer scientists or pursue other careers, the demand for workers who can engage in logical and abstract thinking, data analysis, creative problem solving, troubleshooting, and collaboration has and will increase dramatically. Our shared goal is that all students should have access to CS courses, particularly in high school; however, our analysis of current course-taking patterns finds disparities in access. These disparities disproportionately affect students of color, female students, low-income students, students with disabilities, and English learners.

Key findings include:

- Although CS courses were more widely available in high school than elementary and middle schools, urban high schools were significantly less likely to offer CS than suburban high schools (2% compared to 23%) and half as likely to offer CS as rural schools (10% compared to 23%).
- In schools where CS is available, more white and male students participate, regardless of the student demographics of the school.
- Hispanic and African American students performed more poorly in CS than white and Asian students.
- The majority of K-12 CS courses offered in the Commonwealth in 2016-2017 align with less than one-third of the state's Digital Literacy and Computer Science (DLCS) standards.

[1] This report uses data reported by 374 high schools and 1,288 elementary and middle schools. *High school*s served any combination of grades 9-12. E*lementary and middle schools* served grades other than 9-12.
[2] This report analyzes data from the 2016-2017 school year, the most recent year available.

Definitions and Data

Reporting Courses to DESE

This report examines 99 courses enrolling 392,353 students in 2016-2017: 27 elementary and middle school courses enrolling 314,502 students and 72 high school courses enrolling 77,851 students.

Districts report these data annually to the Department of Elementary and Secondary Education (DESE) via the Student Course Schedule (SCS)[3] system. In order for DESE and other entities to compare information, maintain longitudinal data about students' coursework, and efficiently exchange course-taking records, districts assign a code to each course following standards set by the National Center for Education Statistics (NCES). District staff consult short descriptions of each course in the NCES catalog and match their courses to the most appropriate code.

This system has several limitations:

- NCES course descriptions provide only brief descriptions of the subject covered in a given course. District staff use professional judgement in assigning the appropriate NCES code to each course.
- DESE does not audit local courses for coverage of the standards, nor tie expectations for coverage of the standards to the NCES course descriptions.
- Because the DLCS standards were adopted by the Board of Elementary and Secondary Education (BESE) in June 2016, it is possible that not all of the CS courses taught in 2016-2017 covered the new standards.

Defining CS Courses

As described in more detail below, the vast majority of CS courses offered in the Commonwealth in 2016-2017 appeared to align with less than one-third of the DLCS standards.

For this report, we designated courses as CS if they covered one or more of the 12 standard groupings in the DLCS Curriculum Framework. In making this determination, one must review a description of the course.[4] A handful of courses have very detailed descriptions because they are either open source or offered by a membership association such as the College Board: *Exploring Computer Science*[5], *Computer Science Principles*[6], *AP Computer Science Principles*[7], and *AP Computer Science A*[8]. The majority of courses, however, are locally determined and matched to codes in the NCES catalog, which provides only brief descriptions.

In determining whether a course covered one or more of the DLCS standard groupings, we reviewed course descriptions using keywords from the DLCS Curriculum Framework. A coding schema of *Yes*, *Should*, or *May* represented the likelihood that the course addressed the knowledge and skills

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[3] http://www.doe.mass.edu/infoservices/data/scs/

[4] For example, the computational thinking strand includes the skills of writing and debugging algorithms in a structured language. If language to this effect appeared in the description, the course was designated a CS course.

[5] http://www.exploringcs.org/for-teachers-districts/curriculum

[6] https://studio.code.org/courses/csp-2017

[7] https://apcentral.collegeboard.org/pdf/ap-computer-science-principles-course-and-exam-description.pdf

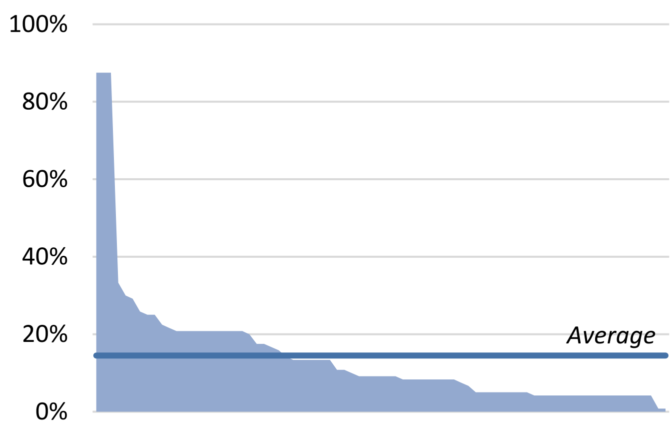
[8] http://media.collegeboard.com/digitalServices/pdf/ap/ap-computer-science-a-course-description.pdf

articulated in each of the 12 standard groupings. We then assigned a percentage to the code. For example, we coded standards explicitly addressed in courses *Yes* and valued them at 8.33%. A course with all 12 standard groupings coded *Yes* covered 100% of the (8.33 x 12 = 100).

Table 1: Determining Coverage of the Standards

Code	Criteria	Value Per Standard Grouping		Total Possible Value
Yes	Standard grouping explicitly addressed in the course description.	8.33%	x12	100%
Should	Standard grouping inferred (but not explicitly addressed) in the course description.	4.165%	x12	50%
May	Standard grouping not explicitly addressed in the course description. It may (or may not) be addressed in the course.	.833%	x12	10%

Figure 1: Percent Coverage of DLCS Standards in CS Courses Taught in 2016-2017
N = 99 Courses



We reviewed 1,819 courses and found that 126 covered a percentage of the DLCS standards.[9] Of those, educators taught 99 courses in the 2016-2017 school year across grades PK-12. Only 3 of the 99 courses covered more than one-third of the DLCS standards (*Exploring Computer Science*, *Computer Science Principles*, and *AP Computer Science Principles* covered 88%). Two courses addressed about one-third of the standards (*AP Computer Science A* and *Mobile Applications*). The remaining 94 courses covered less than 30% of the DLCS standards. The average course covered just 14.5% of the standards, as indicated by the trend line in Figure 1.

Schools Included in the Analysis

This report uses data reported by 374 high schools and 1,288 elementary schools, with *high schools* defined as serving any combination of grades 9-12 and *elementary and middle schools* defined as serving grades other than 9-12.[10] The primary reason for this distinction is that high schools report CS courses separately from courses taught in other grades. Further, it is useful to examine course-taking patterns in the context of a pipeline. For example, since we seek to increase the number of students taking CS in high school, it is important to understand the extent to which students had opportunities to build CS knowledge and skills prior to high school.

[9] Massachusetts Educator Personnel Information Management System (EPIMS) Appendices G1 (Prior to Secondary Subject Area-Course Codes) and G2 (Secondary Subject Area-Course Codes): http://www.doe.mass.edu/infoservices/data/epims/DHAppendices.xlsx

[10] To be included in this report, both types of schools had to enroll a minimum of 10 students in the 2016-2017 school year.

Course Taking Patterns and Student Access, 2016-2017

Student Access

For a student to learn CS, coursework must be available to them. Our analysis found that availability varied by type of school and by region of the state. Among elementary and middle schools, rural schools (59%) tended to offer CS more than urban (44%) or suburban areas (39%). Conversely, students lacked access to CS in 56% of urban schools and 61% of suburban schools. More than a third of rural schools (41%) did not offer CS in 2016-2017.

Although CS courses were more widely available in high school than elementary and middle schools, urban high schools were significantly less likely to offer CS than suburban high schools (2% compared to 23%) and half as likely to offer CS as rural schools (10% compared to 23%).

Figure 2: Difference in Elementary and Middle Schools that Offered CS by Regional Type, 2016-2017

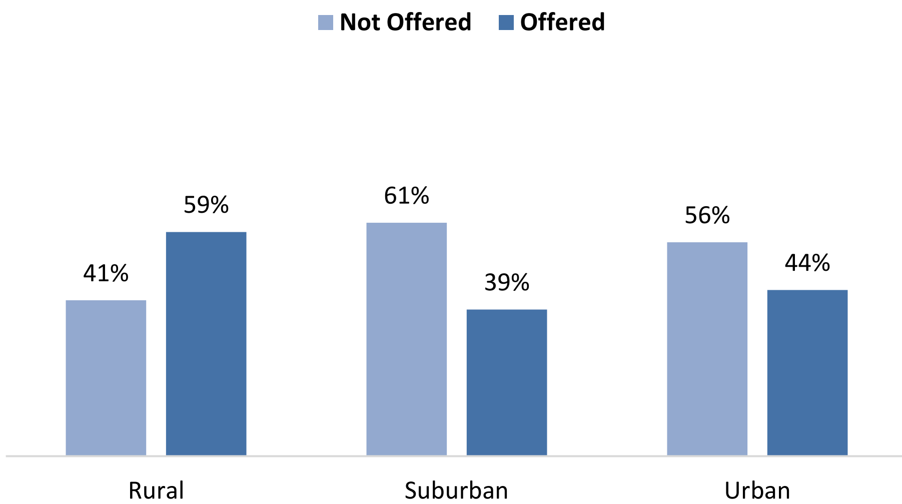
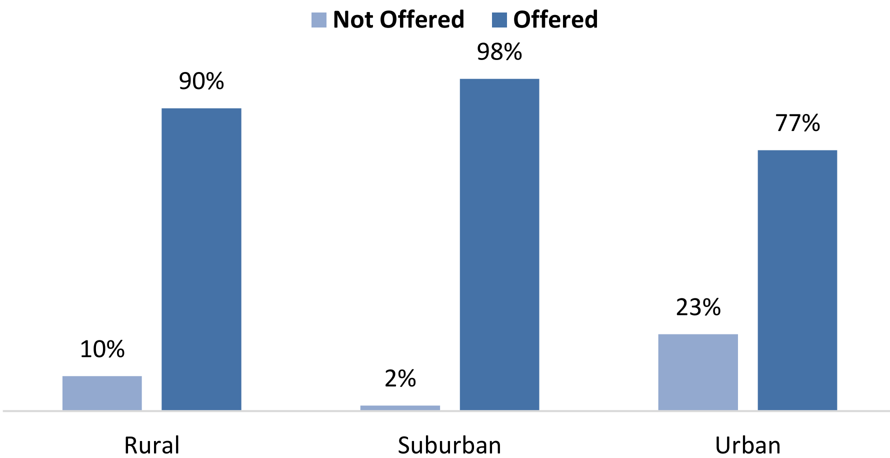


Figure 3: Difference in High Schools that Offered CS by Regional Type, 2016-2017



An important aim of this report is to examine the availability of CS courses to groups of students, particularly for students of color, low-income students, students with disabilities, and English learners.

The first important finding is that overall, more white students attended schools likely to offer CS than students of color, as shown in Figures 4 and 5. The only exception are Hispanic students enrolled in elementary and middle schools, where the likelihood of the school offering CS was about the same (21% compared to 20.4%), as shown in Figure 5.

The second most important finding is that high needs students (a group that includes economically disadvantaged students, students with disabilities, and/or English learners) were less likely to attend an elementary or middle school that offered CS (48.6% compared to 46.1%) and significantly less likely to attend a high school that offered CS (55.6% compared to 39.4%).

Figure 4: Distribution of Students in Elementary and Middle Schools Offering or Not Offering CS by Race and Ethnicity, 2016-2017

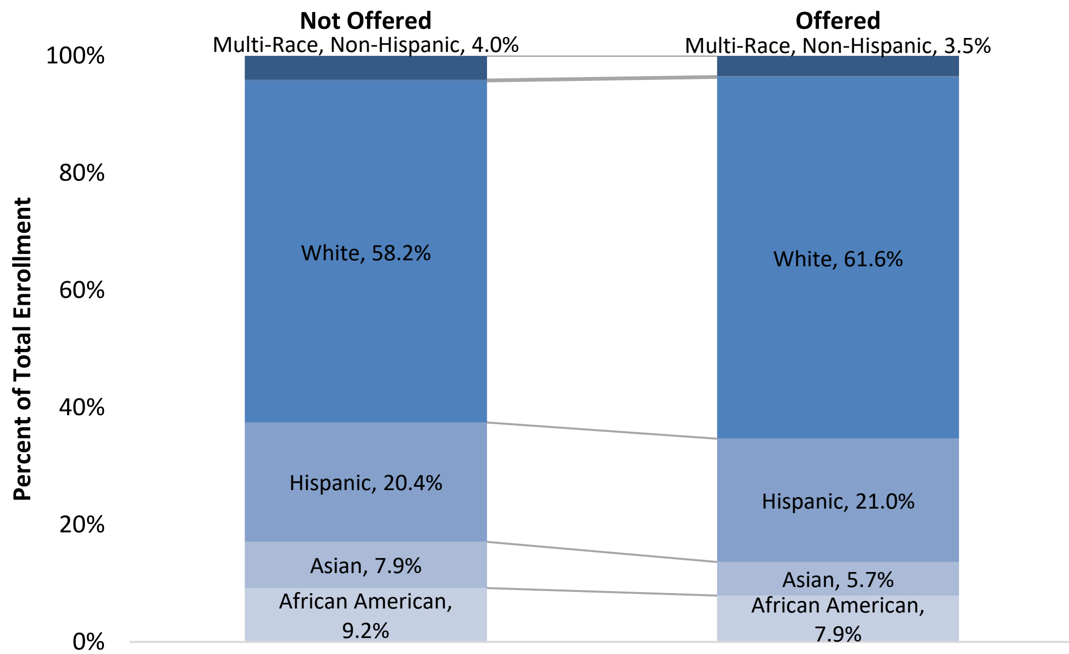


Figure 5: Distribution of Students in High Schools Offering or Not Offering CS by Race and Ethnicity, 2016-2017

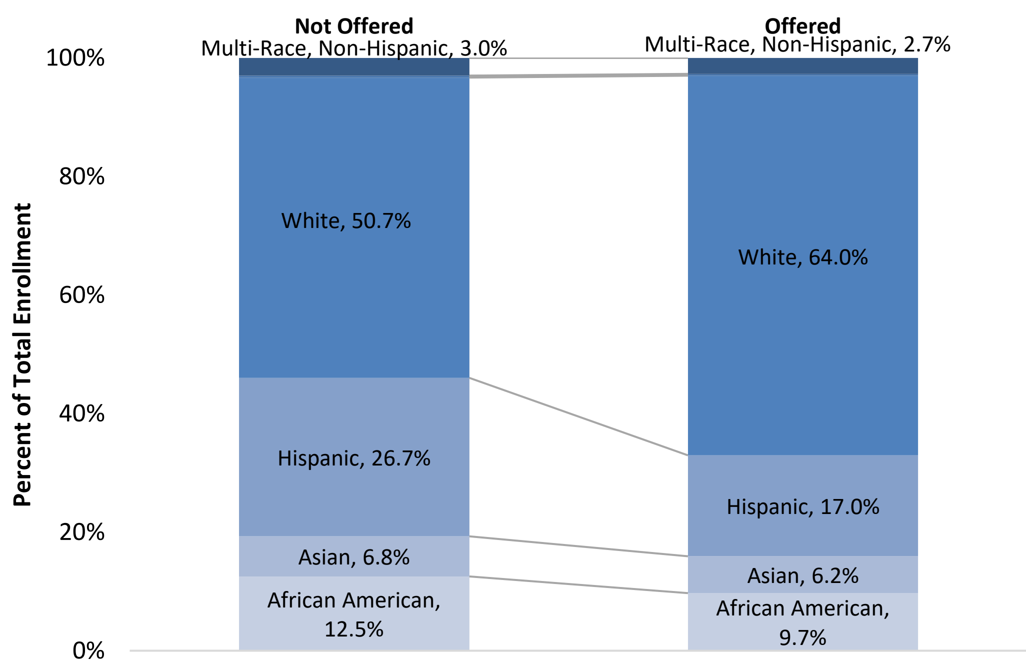


Figure 6: Distribution of Students in Elementary and Middle Schools Offering or Not Offering CS by Special Population, 2016-2017

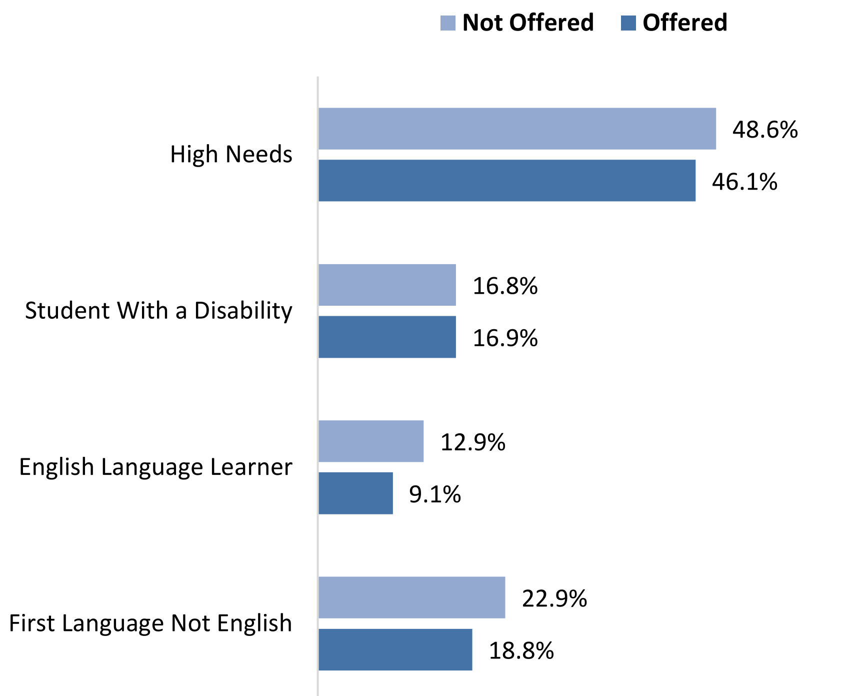
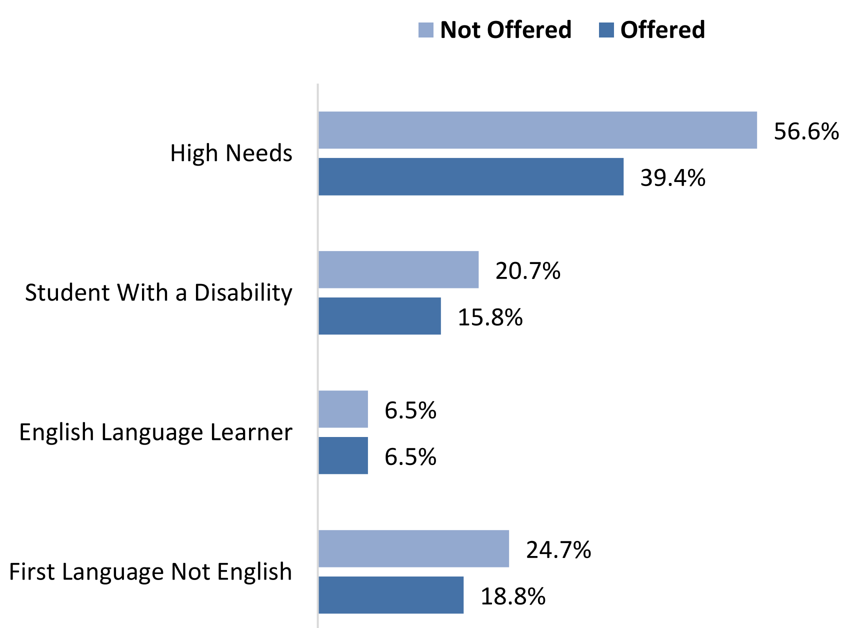


Figure 7: Distribution of Students in High Schools Offering or Not Offering CS by Special Population, 2016-2017



Student Participation

While offering CS in more schools is an important first step in expanding access, it is also important to understand which students are taking CS in schools where it is available.

Figures 8 and 9 show differences in course enrollment within schools that offer CS. The most important finding is this: In schools offering CS, a higher proportion of white students took CS than virtually any other group. The proportion of multi-race, non-Hispanic students taking CS in elementary/middle and high school was about the same, and a higher proportion of Asian students took CS in high school. Because the data only include schools where CS courses exist, these findings are not attributable to a lack of CS teachers or poor technology infrastructure or lack of resources overall.

Figure 8: Differences in Elementary and Middle School CS Course Enrollment by Race and Ethnicity, 2016-2017

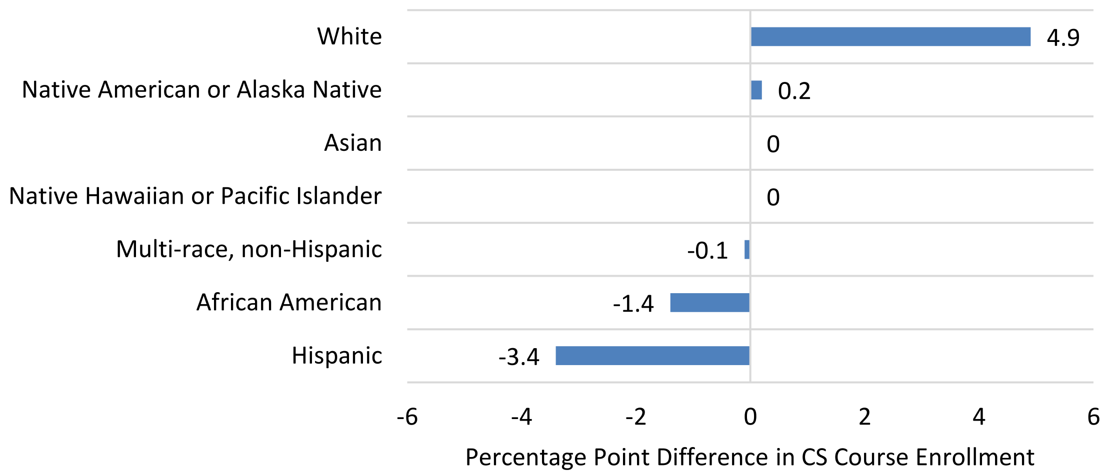
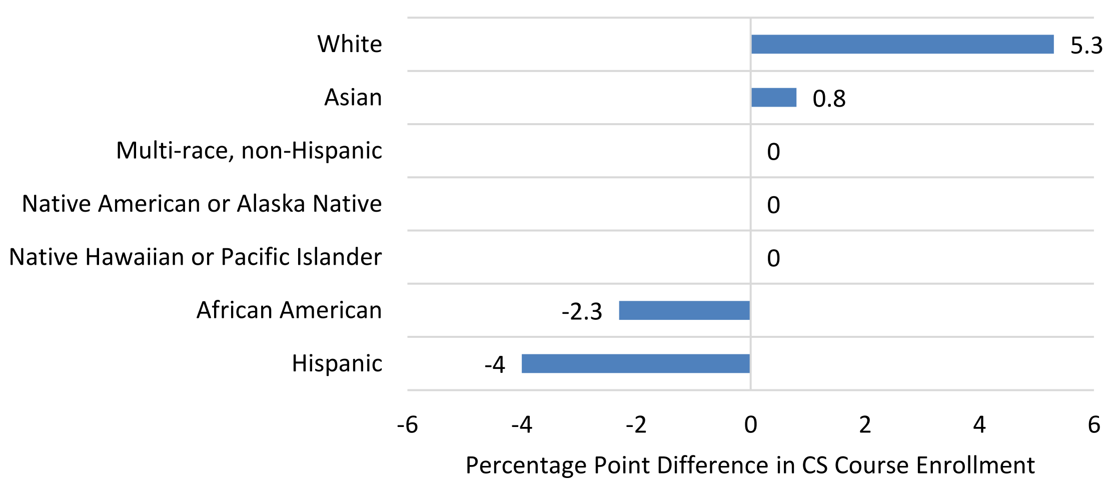


Figure 9: Differences in High School CS Course Enrollment by Race and Ethnicity, 2016-2017



Compounding the problem of overall participation are differences in participation between elementary/middle and high schools. As shown in Table 2, substantially smaller percentage of females took CS in high school as compared to elementary/middle school (-12.9% difference). High school participation also lagged for economically disadvantaged students (-6.3% difference), Hispanic students (-4.3%), English learners (-4.2%) students with disabilities (-3.3%) and multi-race students (-0.7%).

Table 2: Differences in CS Course Enrollment by School Type, 2016-2017

	Elementary and Middle Schools	High Schools	Difference
Female	48.3%	35.4%	-12.9%
Economically disadvantaged	27.8%	21.5%	-6.3%
Hispanic	17.6%	13.3%	-4.3%
English learners	7.9%	3.6%	-4.2%
Students with disabilities	16.1%	12.7%	-3.3%
Multi-race	3.4%	2.7%	-0.7%
African American	6.5%	7.4%	1.0%
Asian	5.7%	7.0%	1.3%
White	66.0%	69.3%	2.8%
Male	51.7%	64.6%	12.9%

Student Participation by Coverage of the DLCS Standards

As discussed earlier in this report, the vast majority of CS courses offered in the Commonwealth in 2016-2017 appeared to align with less than one-third of the DLCS standards. Not surprisingly, most students took CS courses that covered only a small percentage of the standards; in high schools, the courses that covered the most standards enrolled the fewest students overall.

The 27 elementary and middle school CS courses (Appendix B) covered between 4.17% and 20% of the DLCS standards, with a total enrollment of 326,624 students in 2016-2017. *Computer and Information Technology* (17.5% coverage) enrolled the most students (72,197, or about 23%). *Web Page Design* covered the most standards (20%) but enrolled just 320 students. The average course only covered about 8% of the standards.[11]

Coverage of the DLCS standards in the 72 high school CS courses (Appendix C) ranged from 0.8% to 88%. The courses with the greatest coverage (88%) - *AP Computer Science Principles*, *Computer Science Principles*, and *Exploring Computer Science* - combined to enroll a fraction of all high school course-takers (2,375 students, or 3.05%).[12]

Student Performance

Fewer students of color enrolled in CS courses. When we examined pass rates for the courses, we found that students of color had lower pass rates than their peers. In both elementary/middle and high schools, student outcomes differ by race, ethnicity, and special population (e.g., disability or income status). Specifically, African American and Hispanic students, students with disabilities, economically disadvantaged students, and English learners all performed lower than average as compared to other groups.

In elementary and middle schools, student pass rates were as follows in order of highest to lowest and compared to average pass rates: Asian (97.7%), Native Hawaiian or Pacific Islander (95.9%) and white students (95.8%) performed above average (94.6%), while multi-race (93.3%), Native American (93.3%), Hispanic (89.9%), and African American students (89%) performed below average, as shown in Figure 12.

Among other elementary and middle school populations, female student pass rates were slightly above average at (95%) compared to the 94.6% average pass rates; and male students slightly below (94.3%). Students with disabilities (92.2%), economically disadvantaged students (90.2%), and English learners (83.4%) all performed below average, as shown in Figure 13.

In high schools, Native Hawaiian or Pacific Islander (98.9%), white (97.4%), Asian (96.9%) and multi-race students (94.7%) performed above the average pass rates of 94.6%, while Native American (92.7%), Hispanic (86.8%), and African American students (84.7%) performed below average, as shown in Figure 14.

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[11] Total elementary and middle school course enrollment in 2016-2017 was 314,502 students.

[12] Total high school CS course enrollment in 2016-2017 was 77,851 students.

As was the case for elementary and middle schools, females (95.2%) performed slightly above average (94.6%) as compared to male students (94.2%). Students with disabilities (89.2%), economically disadvantaged students (87.6%), and English learners (80.7%) performed below average, as shown in Figure 15.

As compared to their peers enrolled in elementary and middle schools, all racial and ethnic groups except for white (1.6% difference) and multi-race students (1.4% difference) had lower pass rates in high school. High school females performed slightly higher than their elementary and middle school peers (.02% difference) and males slightly lower (-.01% difference).

Figure 12: Pass Rates of Students Enrolled in Elementary and Middle School CS Courses by Race and Ethnicity, 2016-2017

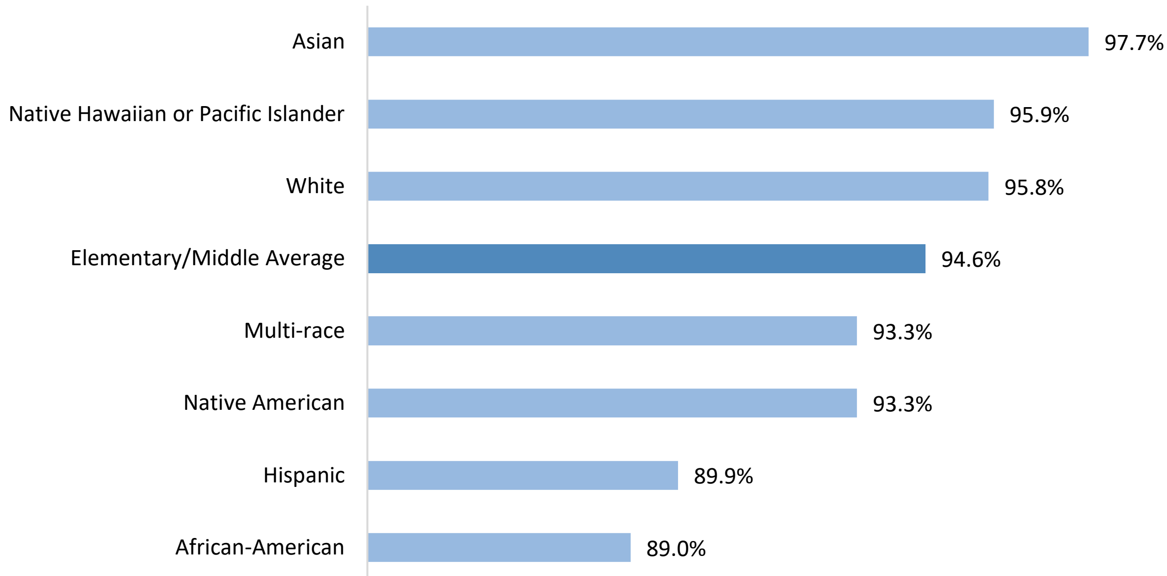

Figure 13: Pass Rates of Students Enrolled in High School CS Courses by Race and Ethnicity, 2016-2017

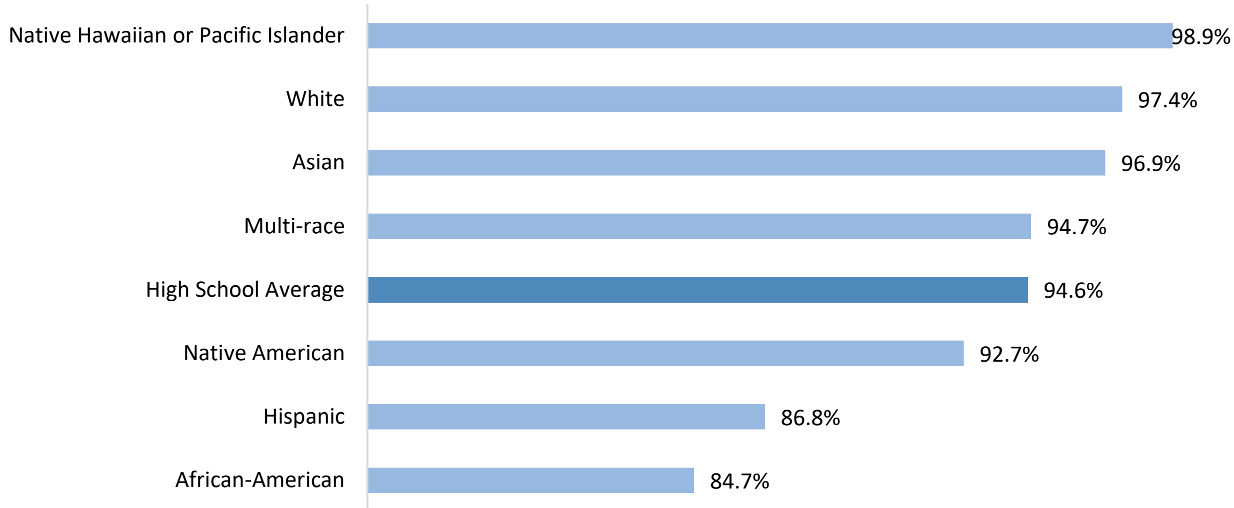

Figure 14: Pass Rates of Students Enrolled in Elementary and Middle School CS Courses by Special Population, 2016-2017

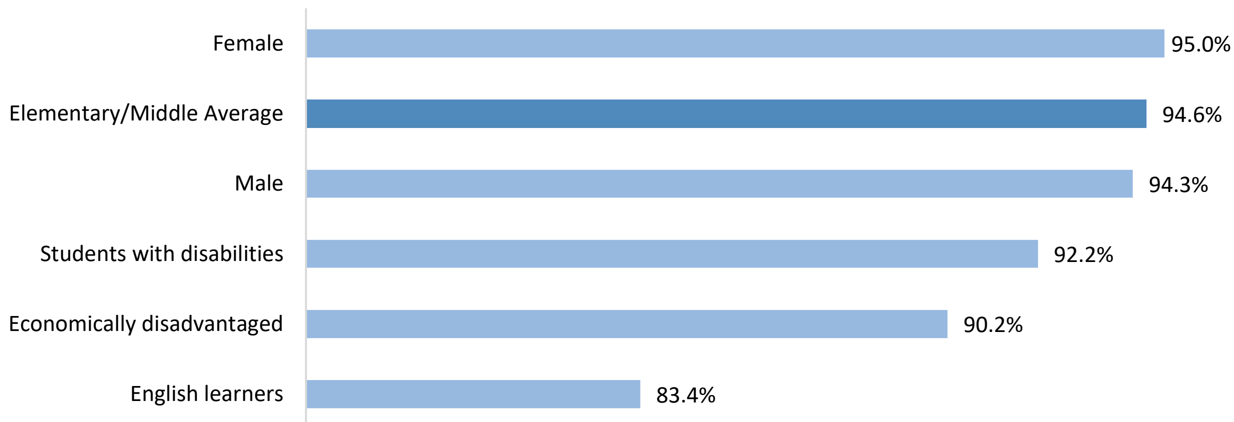

Figure 15: Pass Rates of Students Enrolled in High School CS Courses by Special Population, 2016-2017

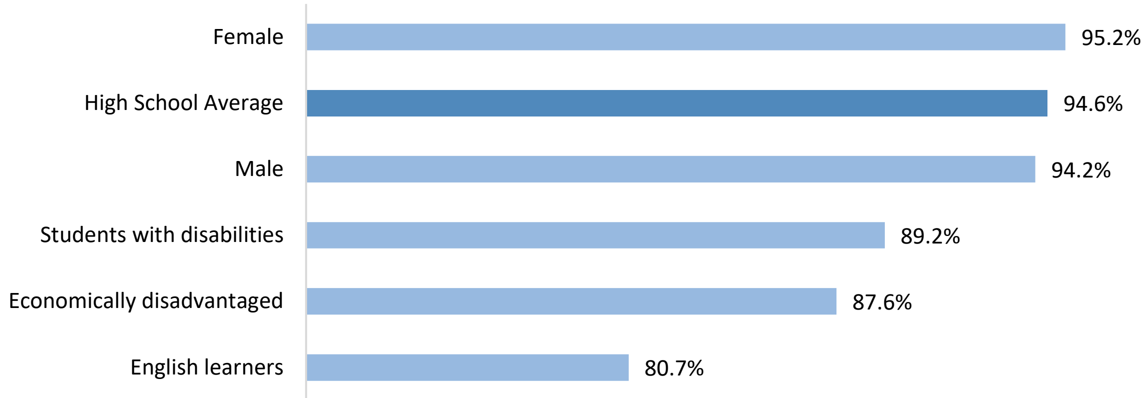

Table 3: Differences in CS Pass Rates by School Type, 2016-2017

	Elementary and Middle Schools	High Schools	Difference
African American	89.0%	84.7%	-4.3%
Hispanic	89.9%	86.8%	-3.1%
Students with disabilities	92.2%	89.2%	-3.0%
English learners	83.4%	80.7%	-2.7%
Economically disadvantaged	90.2%	87.6%	-2.6%
Asian	97.7%	96.9%	-0.8%
Native American	93.3%	92.7%	-0.6%
Male	94.3%	94.2%	-0.1%
Female	95.0%	95.2%	0.2%
Multi-race	93.3%	94.7%	1.4%
White	95.8%	97.4%	1.6%

Recommendations for Expanding Access and Studying Results

In order to achieve equity in access to CS in Massachusetts, we need to consider a combination of incentives, strategies, and supports, along with robust measures of success. A 2017 study commissioned by BNY Mellon[13] lays out a blueprint for expanding access to CS for all students. It identified the following 10 priorities:

- A state plan for K-12 CS education
- State-level initiatives to address diversity in CS education
- Adoption of K-12 CS standards
- State-level funding for K-12 CS education
- State CS teacher certification
- State-approved pre-service teacher preparation programs at institutions of higher education
- A dedicated state-level CS education position
- A requirement for all high schools to offer CS
- CS can satisfy a core high school graduation requirement
- CS can satisfy a core admission requirement at postsecondary institutions

Massachusetts has made strides in these areas: We adopted standards and a DLCS teacher license (in addition to the preexisting instructional technology specialist license, which has a coaching focus); we are inviting teacher preparation programs to apply to offer the DLCS teacher license; and we have a designated within DESE a DLCS Content Support Lead.

Massachusetts is also taking steps to develop a plan for K-12 CS education that includes providing training and resources to support the implementation of the DLCS Curriculum Framework, and the exploration of grants and other funding opportunities to provide resources and training to districts. Elements of the plan include:

- Providing professional development focused on developing the capacity of teachers and schools to integrate computational thinking (CT) standards in science and technology/engineering (STE) and mathematics curricula in grades 1-6 with integrity and authenticity through providing students with relevant, accessible, real-world contexts that are aligned to the Curriculum Frameworks. Participants build a shared understanding of the complementary DLCS and mathematics or STE standards by grade level, and learn strategies and structures that

[13] Stanton, J., et al. (2017). *State of the states landscape report: State-level policies supporting equitable K-12 computer science education*. Retrieved June 1, 2018 from https://www.ecs.org/wp-content/uploads/MassCAN-Full-Report-v10.pdf.

strengthen and balance DLCS and math or DLCS and STE instruction and learning. This opportunity will be delivered at three levels:

  - Individual teachers looking to integrate CT in their own mathematics or science classes;
  - Coaches (e.g., Instructional Technology Specialists) looking for a more in-depth professional learning experience to coach or provide professional development educators in their school or district in integrating CT in their mathematics or science classes; and
  - DLCS Ambassadors, educators looking for a more in-depth professional learning experience and committed to providing professional development to other schools and districts on CT integration.

- In partnership with K-8 educators, building out an existing guide for integrating CS into the curriculum for grades 1-6 (developed under the National Science Foundation's STEM+C initiative) to include grades K-8 and articulate opportunities for teaching the DLCS standards within the English language arts, health, and history and social science standards in addition to STE and mathematics standards already included in the guide. This working group will also identify aligned instructional materials and suggest professional development opportunities for each grade that support CT integration.
- Pursuing opportunities to develop and pilot a four-year, integrated course of study that combines CS and mathematics, and explore the development of a similar multi-year pathway in science.

Massachusetts can take additional steps to achieve equitable access to CS, particularly for its most under-served students:

- **Amend MassCore, the Commonwealth's recommended course of study for all high school students, to allow a CS course that includes rigorous mathematical or scientific concepts and aligns with the DLCS standards to be substituted for either a laboratory science course or for a mathematics course.** CS is an important addition to the academic program: it forms the basis for a significant and growing component of the Commonwealth's knowledge-based economy in the twenty-first century, and its knowledge and skills are foundational for students interested in pursuing a wide variety of careers in science, technology, engineering, mathematics, and beyond. Integrating rigorous mathematical or science concepts into CS helps students make connections among content. Including CS in MassCore creates incentives for schools to provide standards-aligned learning experiences throughout the PK-12 pipeline. If students take CS in high school, they are more likely to pursue CS in college and career.
- **Identify robust and academically rigorous high school CS courses or course sequences aligned to the DLCS standards to be included as acceptable substitutions for MassCore mathematics and laboratory science courses.** Most students do not take courses aligned to the DLCS standards; increasing the type and variety of courses (e.g., online, dual enrollment, early college, etc.) provides more equitable access to students, even if they attend schools not currently offering computer science.

- **Identify strategic opportunities for increasing the capacity of all educators to teach CS concepts, as well as the supply of licensed CS teachers.** In addition to the work already underway as described above, other critical work includes pre-service training and in-service professional development focused on increasing equity in the student population taking CS.
- **Collect and use data to measure success and inform policy decisions.** Building on the data in this report, collecting data annually on access, participation, and performance in CS courses helps tell us where we are succeeding and where there is still work to do.

Increasing access to a high quality, standards-aligned CS education for *all* students will have lasting positive effects, both in terms of economics *and* inclusion. In 2017, Tom Hopcroft, President and CEO of the Massachusetts Technology Council and current member of the Board of Higher Education, wrote:

> *We need to expand the employable talent pool which requires an educated and inclusive workforce. As a leading education and innovation state that is nevertheless struggling to find the talent to fuel our growth, Massachusetts must educate all students to be creators and not just consumers of technology. Inclusive organizations yield stronger company performance while providing greater opportunities. By setting specific and actionable goals, using benchmarks, learning from peers, and maintaining accountability we will improve our success in this 21st century economy.*[14]

[14] Mass Technology Leadership Council. (2017). *Tech industry transformation: Platform ecosystems, economic models, and the future of work*. Retrieved June 1, 2018 from http://www.masstlc.org/state-of-technology-2017-tech-industry-transformation/.

Appendix A: Digital Literacy and Computer Science (DLCS) Curriculum Framework

Adopted by the Board of Elementary and Secondary Education (BESE) in 2016, the Digital Literacy and Computer Science (DLCS) Curriculum Framework articulates learning standards for kindergarten through twelfth grade. Grouped into four strands (*Computing and Society*, *Digital Tools and Collaboration*, *Computing Systems*, and *Computational Thinking*), the standards define what a student should know and be able to do as a result of instruction within four grade spans (*K-2*, *3-5*, *6-8*, and *9-12*).

Computing and Society

1. Understand safety and security concepts, security and recovery strategies, and how to deal with cyberbullying and peer pressure in a social computing setting.
2. Understand, analyze impact and intent of, and apply technology laws, license agreements and permissions.
3. Recognize, analyze, and evaluate the impact of technology, assistive technology, technology proficiencies, and cybercrime in people's lives, commerce, and society.

Digital Tools and Collaboration, Computing Systems

4. Selection and use of digital tools or resources and computing devices to create an artifact, solve a problem, communicate, publish online or accomplish a real-world task.
5. Use of advance research skills including advanced searches, digital source evaluation, synthesis of information and appropriate digital citation.
6. Understand how computing device components work. Use of troubleshooting strategies to solve routine hardware and software problems.
7. Understand how networks communicate, their vulnerabilities and issues that may impact their functionality. Evaluate the benefits of using a service with respect to function and quality.

Computational Thinking

8. Creation of new representations, through generalization and decomposition. Write and debug algorithms in a structured language.
9. Understand how different data representation affects storage and quality. Create, modify, and manipulate data structures, data sets, and data visualizations.
10. Decompose tasks/problems into sub-problems to plan solutions.
11. Creation of programs using an iterative design process to create an artifact or solve a problem.
12. Creation of models and simulations to formulate, test, analyze, and refine a hypothesis.

Throughout the strands, students learn to employ seven practices: *Connecting*, *Creating*, *Abstracting*, *Analyzing*, *Communicating*, *Collaborating*, and *Research*. Each contributes to the development of analytical reasoning, specifically in using technology to solve problems.

Appendix B: Elementary/Middle School CS Enrollment by Coverage of DLCS Standards, 2016-2017

Elementary/Middle School Courses	% of DLCS Standards Covered (Est.)	Student Enrollment	Percentage of Total Enrollment
Photo Imaging	4.17%	107	0.03%
Broadcasting Technology	4.17%	172	0.05%
Keyboarding	4.17%	1,596	0.51%
IB Technology - Middle Years Program	4.17%	2,275	0.72%
Pre-Engineering Technology	4.17%	19,647	6.25%
Computer Applications	4.17%	19,938	6.34%
Word Processing	5.00%	73	0.02%
Desktop Publishing	5.00%	86	0.03%
Audio/Visual Production	5.00%	1,224	0.39%
Engineering Technology	5.00%	21,931	6.97%
Computer Literacy	5.00%	52,133	16.58%
Introduction to Computers	6.67%	57,900	18.41%
Engineering Applications	7.50%	2,915	0.93%
Engineering - Comprehensive	8.33%	699	0.22%
Particular Topics in Computer Literacy	8.33%	3,852	1.22%
Engineering Design	8.33%	6023	1.92%
Technological Literacy	8.33%	31,063	9.88%
Computer Graphics	9.17%	1,504	0.48%
Introduction to Communications	9.17%	1,643	0.52%
Digital Media Technology	9.17%	3,917	1.25%
Interactive Media	9.17%	3,930	1.25%
Principles of Engineering	9.17%	4,344	1.38%
Computing Systems	10.00%	1,478	0.47%
Robotics	10.83%	3,061	0.97%
Communications Technology	13.33%	474	0.15%
Computer and Information Technology	17.50%	72,197	22.96%
Web Page Design	20.00%	320	0.10%
Total		**314,502**	**100%**

Appendix C: High School CS Enrollment by Coverage of DLCS Standards, 2016-2017

High School Courses	% of DLCS Standards Covered (Est.)	Student Enrollment	Percentage of Total Enrollment
Drafting—General	0.83%	821	1.05%
Graphic Design	0.83%	4981	6.40%
Computer Programming— Other	4.17%	272	0.35%
Computer-Assisted Art	4.17%	3819	4.91%
Emerging Technologies	4.17%	127	0.16%
Business Computer Applications	4.17%	754	0.97%
Broadcasting Technology	4.17%	1838	2.36%
Computer Applications	4.17%	9048	11.62%
Keyboarding	4.17%	748	0.96%
Recordkeeping	4.17%	73	0.09%
Library/AVC Aide	4.17%	161	0.21%
CAD Design and Software	4.17%	2896	3.72%
Office Procedures— Comprehensive	4.17%	4	0.01%
Business Communications	4.17%	195	0.25%
Particular Topics in Computer Programming	4.17%	422	0.54%
Computer Programming— Independent Study	4.17%	9	0.01%
Photo Imaging	4.17%	1057	1.36%
Word Processing	5.00%	407	0.52%
Desktop Publishing	5.00%	1111	1.43%
Audio/Visual Production	5.00%	3990	5.13%
Graphic Technology	5.00%	1456	1.87%
Engineering Technology	5.00%	3399	4.37%
Technological Processes	5.00%	23	0.03%
Commercial Graphic Design	5.00%	877	1.13%
Introduction to Computers	6.67%	1264	1.62%
Engineering Design	8.33%	2390	3.07%
Digital Media Design and Production	8.33%	1952	2.51%
Engineering Analysis	8.33%	21	0.03%
Database Applications	8.33%	2	0.00%
Engineering Design and Development	8.33%	672	0.86%
Technological Literacy	8.33%	257	0.33%
Particular Topics in Computer Literacy	8.33%	1287	1.65%
Computer Graphics	9.17%	3141	4.03%
Interactive Media	9.17%	1132	1.45%

High School Courses	% of DLCS Standards Covered (Est.)	Student Enrollment	Percentage of Total Enrollment
Introduction to Communication	9.17%	337	0.43%
Principles of Engineering	9.17%	1270	1.63%
Digital Media Technology	9.17%	1279	1.64%
Computing Systems	10.00%	146	0.19%
Business Programming	10.83%	73	0.09%
Robotics	10.83%	3625	4.66%
IB Information Technology in a Global Society	13.33%	130	0.17%
Communication Technology	13.33%	169	0.22%
Telecommunications (Communication)	13.33%	265	0.34%
Telecommunications	13.33%	116	0.15%
Computer Technology	13.33%	1106	1.42%
Data Systems/ Processing	14.17%	62	0.08%
Computer Integrated Manufacturing	15.83%	137	0.18%
CISCO—The Panduit Network Infrastructure Essentials (PNIE)	16.67%	16	0.02%
Computer Programming— Other Language	17.50%	377	0.48%
Computer and Information Technology	17.50%	2998	3.85%
Web Page Design	20.00%	3871	4.97%
C++ Programming	20.83%	375	0.48%
JAVA Programming	20.83%	1137	1.46%
Wide Area Telecommunications and Networking	20.83%	48	0.06%
Network Technology	20.83%	217	0.28%
Router Basics	20.83%	2	0.00%
NetWare Routing	20.83%	2	0.00%
Information Support and Services	20.83%	81	0.10%
Microsoft Certified Professional (MCP)	20.83%	123	0.16%
Area Network Design and Protocols	20.83%	8	0.01%
Computer Math with Algebra	20.83%	90	0.12%
Computer Programming	21.67%	3781	4.86%
Information Management	22.50%	24	0.03%
IB Mathematics and Computing—SL	25.00%	206	0.26%
VISUAL BASIC Programming	25.00%	634	0.81%
Computer Gaming and Design	25.83%	128	0.16%
IB Computing Studies	29.17%	84	0.11%
Mobile Applications	30.00%	51	0.07%
AP Computer Science A	33.33%	1902	2.44%

High School Courses	% of DLCS Standards Covered (Est.)	Student Enrollment	Percentage of Total Enrollment
Exploring Computer Science	87.50%	1877	2.41%
AP Computer Science Principles	87.50%	152	0.20%
Computer Science Principles	87.50%	346	0.44%
Total		**77,851**	**100%**