Maine Computer Science Task Force Report

(LD 398)

Published on January 17, 2018

That the Science, Technology, Engineering and Mathematics Council, referred to in this resolve as "the council," shall establish and convene a computer science education task force, referred to in this resolve as "the task force," to develop an informed strategy to integrate computer science into the State's proficiency-based high school diploma requirements, as well as to expose all students to computer science as a basic skill and as a potential career path.

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Executive Summary

Task Force Creation

The Maine Computer Science (CS) Task Force was created as a result of LD 398: "Resolve, To Establish the Task Force To Recognize Computer Science in the Path to Proficiency" during the 128th Legislature. The bill outlined that the CS Task Force would be established under the existing Maine STEM Council as a short-term task force focused on understanding the computer science education landscape in Maine and across the country, providing best practices for computer science teacher professional development, and making recommendations to expand computer science education in the path to proficiency in Maine's K-12 schools. The Task Force consisted of 12 members representing K-12 education, higher education, the non-profit community, and computer science content specialists. The task force held nine meetings from October of 2017 until January of 2018.

Maine students need the same access to high quality computer science education as students from other states. The task force members want to provide this access through thoughtful planning which ensures rigorous computer science standards, high quality teacher professional development, appropriate implementation resources, and an aggressive timeline to provide access to Maine students.

Maine Landscape

Computer science courses are offered throughout Maine schools in all 16 counties, in both rural and urban communities, and in career and technical education centers, but Maine students do not have equal access to computer science education. According to a recent national census from Code.org which surveyed 203 Maine schools, 30% of the K-12 schools offer computer science education. Maine students are missing out on essential computational skills which are required for success in 21st century jobs. 71% of new STEM jobs are in computing occupations. Computer Science is a part of every industry including healthcare, manufacturing, information technology, and a variety of other essential Maine industries.

Recommendations

This report outlines the essential recommendations to expand computer science education in Maine and offers specific strategies to accomplish these recommendations. In order to accomplish these recommendations, collaboration between the Maine Legislature, the Maine Department of Education, the non-profit community, K-16 education leaders, and industry leaders will be essential.

1. Adopt rigorous computer science standards as part of existing science and technology standards areas.
2. Expand computer science to all Maine middle schools by 2021.
3. Invest in growing the number of trained computer science teachers through high quality inservice programs and expanding preservice teacher programs.
4. The Maine Department of Education should lead the vision to expand computer science education in Maine through collaboration with the CS4ME Coalition and other supportive partners.
5. Maine's Higher Education institutions should support and encourage high school students to take computer science courses.
6. Continue to foster and grow community engagement in expanding computer science education.

Background

What is computer science?

The United States Department of Education defines computer science as "the study of computers and algorithmic processes and includes the study of computing principles and theories, computational thinking, computer hardware, software design, coding, analytics, and computer applications. Computer science often includes computer programming or coding as a tool to create software including applications, games, Websites, and tools to manage or manipulate data; development and management of computer hardware and the other electronics related to sharing, securing, and using digital information. In addition to coding, the expanding field of computer science emphasizes computational thinking and interdisciplinary problem-solving to equip students with the skills and abilities necessary to apply computation in our digital world. Computer science does not include using a computer for everyday activities, such as browsing the internet; use of tools like word processing, spreadsheets or presentation software; or using computers in the study and exploration of unrelated subjects."

National Computer Science Education Movement

The Association for Computing Machinery, Code.org, Computer Science Teachers Association, Cyber Innovation Center, and National Math and Science Initiative have collaborated with states, districts, and the computer science education community to develop conceptual guidelines for computer science education.

The K–12 Computer Science Framework comes at a time when our nation's education systems are adapting to a 21st century vision of students who are not just computer users but also computationally literate creators who are proficient in the concepts and practices of computer science. States, districts, and organizations can use the framework to inform the development of standards and curriculum, build capacity for teaching computer science, and implement computer science pathways.

The K-12 Computer Science Framework is designed to guide computer science from a subject for the fortunate few to an opportunity for all. The K–12 Computer Science Framework (k12cs.org) provides overarching, high-level guidance per grade bands, while the standards provide detailed, measurable student performance expectations. The Framework was considered as a primary input for the standards development process.

The CSTA Standards Revision Task Force crafted computer science standards (https://www.csteachers.org/page/standards) by combining concept statements and practices from the Framework. It also used descriptive material from the Framework when writing examples and clarifying statements to accompany the standards. The major focus areas of the standards include computing systems, networks and the internet, data and analysis, algorithms and programming, and the impacts of computing.

Computer Science for All (csforall.org) is a national initiative supporting students in grades kindergarten through high school to gain important computer science skills like computational thinking to be able to thrive in the digital economy and be active creators of technology. Computer science is a basic skill needed by all students for success in the future. The CSforAll Consortium is the hub for the CSforAll movement which advocates for rigorous K-12 computer science education for all students. Many states have adopted the

CSforAll model to organize state coalitions or non-profit organizations to lead computer science expansion efforts. For example, Texas (CS4TX.org) and Rhode Island (CS4RI.org) have similar models.

The College Board has been a leader in the computer science national movement. The College Board has two AP computer science courses. AP Computer Science A offers students the opportunity to learn the fundamentals of programming using the programming language, JAVA. A new AP course (launched in 2016), AP Computer Science Principles, offers students the opportunity to learn the fundamentals of computing, which includes topics from problem solving to data to cybersecurity to programming. This course is accessible by all high school students and does not require any prerequisites. It is an introductory course designed to offer all students foundational computer science skills.

The National Science Foundation (https://www.nsf.gov/news/special_reports/csed/index.jsp) has significantly invested in computer science education by supporting a variety of research-driven projects across the country to better understand teaching best practices for computer science and broaden participation in computer science among underrepresented students.

President Obama championed Computer Science for All by building on the existing efforts in individual states and calling for increased access to computer science courses for all K-12 students. His initiative called for additional federal funding to support computer science, continued collaboration with CS leaders from across the United States, and additional engagement of industry partners to provide computer science access to all students.

President Trump recently directed the U.S. Department of Education to commit 200 million dollars per year in competitive grant funds to STEM projects with an emphasis on computer science. The specific guidelines for this funding have not been released, but more information should be available in the spring. It should be noted this money represents a redirection of existing funds rather than new funding to support STEM projects.

The Governors' Partnership for Computer Science is a group of bipartisan state leaders focused on expanding computer science education through increased policy advances, funding, and improved equity. 16 Governors (Republicans and Democrats) are now part of the partnership and have committed to working toward these important policy priority areas: enabling all high schools to offer a computer science course, fund teacher professional development, and create high quality computer science standards to guide the implementation of courses.

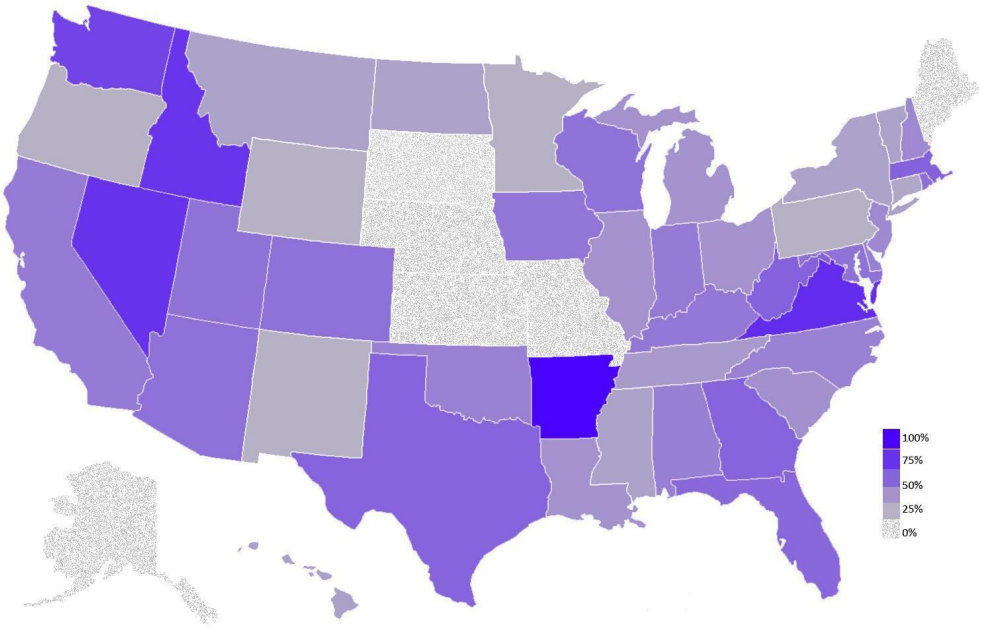
Private industry has also supported the expansion of computer science to students across the United States. In September of 2017, a variety of companies announced their investment in computer science education (Resource 4). Details about accessing this funding have not been released.

Maine Is Falling Behind

High quality computer science education is happening in limited schools across the state. Code.org, a non-profit which supports computer science education, is conducting a national survey to better understand which schools in each state offer computer science courses. 203 Maine schools have completed the survey over the last few months which represents 28% of K-12 schools in Maine. 30% of the schools who responded currently offer some computer science.

Unfortunately Maine students do not have equitable access to computer science. State policies and additional resources would help expand computer science to reach more Maine students.

Below are visual representations of Maine compared to other states across the country regarding providing students access to high quality computer science education.



This map shows the percent of the 9 policy areas each state has accomplished to expand computer science to all students. Here is a list of the nine computer science education advocacy areas:

1. A state plan for computer science
2. Define computer science and establish rigorous computer science standards
3. Allocate funding for teacher professional development
4. Clear teacher certification pathways for computer science teachers
5. Create computer science pre-service teacher programs
6. Establish dedicated computer science positions in state and local education agencies
7. Require all secondary schools to offer computer science
8. Allow computer science to count as a graduation requirement
9. Allow computer science to satisfy an admissions requirement in higher education institutions

Recommendations For Expanding Computer Science Education In Maine

Each of the recommendations in this section are explained in further detail later in the document. The Accomplishing Recommendations section details the current state of the area in Maine and strategies for accomplishing the recommendation.

1. Adopt rigorous Computer Science Standards as part of the existing science and technology standards areas.

a. Collaborate with the Maine Department of Education to include appropriate computer science standards in the standards review process for science and technology. This recommendation requires teachers with computer science knowledge to serve on the science standards steering committee starting in the spring of 2018. The goal is to add additional computer science standards to this content area to address the major computer science concepts/skills.

b. Use the K-12 CSTA Computer Science Standards (Resource 1) as the foundation to connect student learning in science to computer science and adding computer science standards where appropriate. These standards have been drafted by national leaders in computer science education representing a variety of organizations. They have been endorsed by the Computer Science Teachers Association.

c. Support local districts' efforts to recognize student learning in computer science classes as evidence toward proficiency-based diplomas in one of the required content areas by creating resources that demonstrate to schools the connection between computer science content and existing content area standards. These resources should be a collaboration of the Maine Department of Education and Computer Science content area specialists.

More details about accomplishing this recommendation can be found on page 10.

2. Expand computer science to all Maine middle schools by 2021.

a. The State should adopt a goal to support all Maine middle schools to offer computer science classes by 2021. The State should use data to track schools who are adding these programs and encourage other schools to adopt as well.

b. Allow a rigorous Computer Science course to count for the required middle school CTE experience (Public Law Chapter 171) which the Maine Department of Education is working to implement for 2018/2019.

More details about accomplishing this recommendation can be found on page 11.

3. Invest in growing the number of trained computer science teachers through high quality inservice programs and expanding preservice teacher programs.

a. Maine non-profit organizations, higher education institutions, and national providers should continue expanding their outreach efforts across the state to help train K-12 computer science teachers through inservice and preservice teacher programs.

b. In order to train at least one middle school teacher to teach computer science for each middle school in Maine (~200), make a 1.2 million dollar financial investment in high quality computer science professional development programs over the next 3 years. Code.org estimates the cost to train a teacher at the middle school level is ~$6000.

c. The Maine Department of Education should design a new teacher certification or endorsement pathway specifically for computer science teachers to teach grades 6-12 in order to support high quality computer science teachers. During the creation of this teacher certification or endorsement pathway, great care should be taken to allow existing computer science teachers to continue teaching by considering grandfathering or a time period under which they can get to certification status while still teaching. It is essential there are a variety of short and long-term options for ensuring highly qualified teachers.

More details about accomplishing this recommendation can be found on page 12.

4. The Maine Department of Education should lead the vision to expand computer science education in Maine through collaboration with the CS4ME Coalition and other supportive partners.

a. The Maine Department of Education should create a statewide plan for computer science to communicate the vision, goals, and implementation of K-12 computer science in Maine. This report will be a helpful starting place for the information needed for that plan.

b. The Maine Department of Education should assign a staff member to serve as the K-12 computer science liaison. A staff member is needed to effectively support the implementation of computer science across Maine schools. Major priorities would include:

i. person with dedicated time to support CS teachers in Maine

ii. advocate for continued growth of CS in Maine through supporting efforts for computer science standards integration

iii. advocate for the development of multiple pathways for preservice and inservice teachers to become CS teachers.

More details about accomplishing this recommendation can be found on page 14

5. Maine's Higher Education institutions should support and encourage high school students to take computer science courses.

a. Maine higher education institutions should allow rigorous computer science to count as an admissions requirement just like other rigorous science courses.

b. The expansion of dual enrollment/early college opportunities is needed at both community colleges and four-year institutions to provide greater access to computer science courses and develop clear computer science pathways for students to understand how to pursue future opportunities in Maine.

More details about accomplishing this recommendation can be found on page 15.

6. Continue to foster and grow community engagement in expanding computer science education.

a. Connect all of the supporters for computer science education through a grassroots coalition, CS4ME, to continue the work of the CS Task Force and widen the participation of organizations, higher education institutions, industry partners, and members of Maine Computer Science Teachers Association.

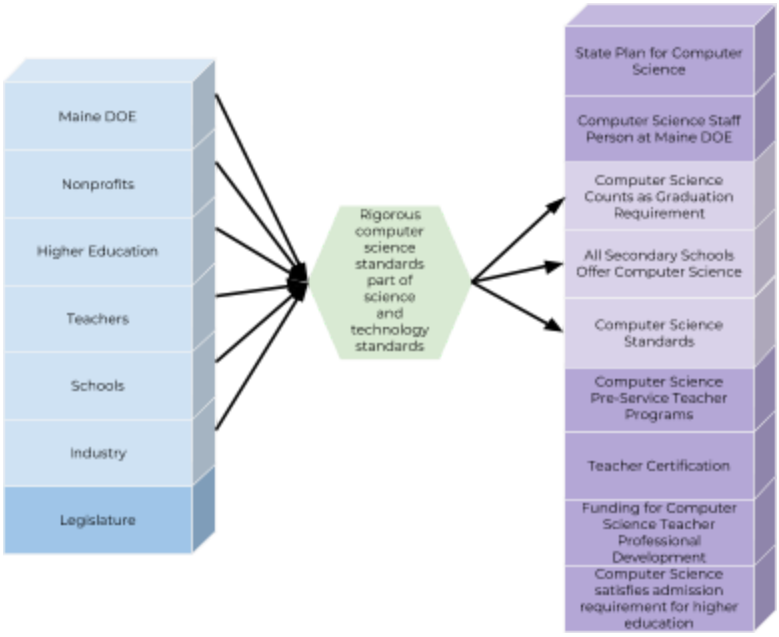
More details about accomplishing this recommendation can be found on page 18.

Accomplishing Recommendations

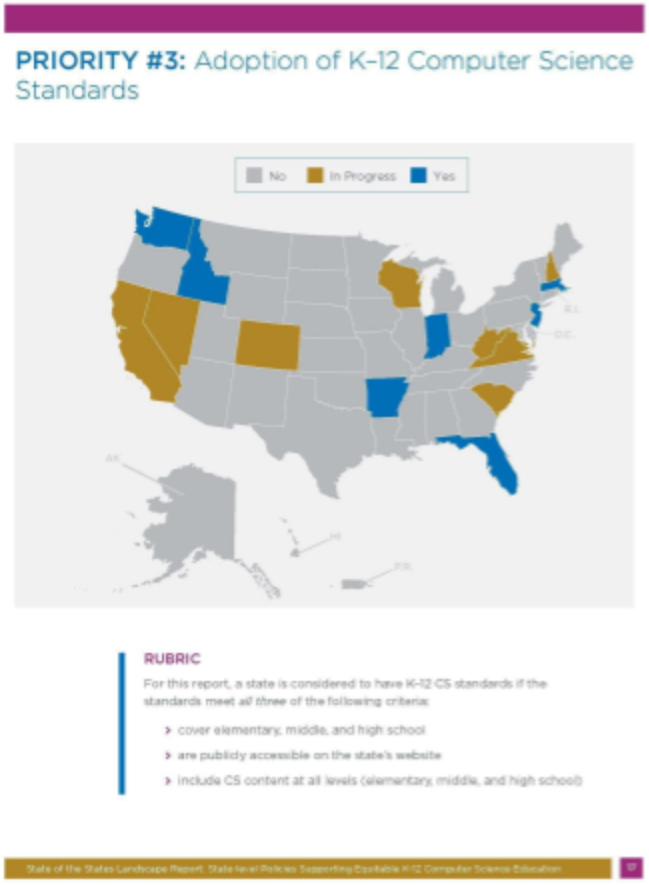
Adopt rigorous Computer Science Standards as part of the existing science and technology standards areas.

In order to attain a high school diploma, Maine students are required to demonstrate proficiency in a variety of content areas. For students planning to graduate in 2021, they must demonstrate proficiency in the following content areas: English language arts, social science, science and technology, and mathematics. In each following year through 2025, the proficiency requirements increase until the law is fully implemented in 2025.

The task force recognizes the time and resources that have been invested to support students, teachers, and schools to support the proficiency-based diploma requirements.



Computer science is not currently recognized as one of the required content areas for students to earn a high school diploma, but would fit comfortably in the existing science and technology area.



Source: State of the States Landscape Report (Resource 3)

Science is often looked at as the place where students learn about how the world around them works. With computers being such a key part of the world students live in, understanding how computers work needs to be a part of every students K-12 education.

Around the country states are adding computer science standards. In the graphic above you can see the states which had or were in the process of adopting computer science standards in March of 2017. That number continues to grow with Pennsylvania adopting standards just this month.

The science standards are up for review in 2018. During the existing process the Maine Department of Education should invite computer science content specialist to be part of both the steering committee and writing team. In the science standards are already broken down into different areas of study. Adding this area of study expands the options available to schools to design the best learning path for their students.

Some schools are already planning to have all students to take computer science classes. For

example, Orono High School has all 9th graders take one semester of computer science. Lyman Moore Middle School has a plan for all middle school students to take computer science.

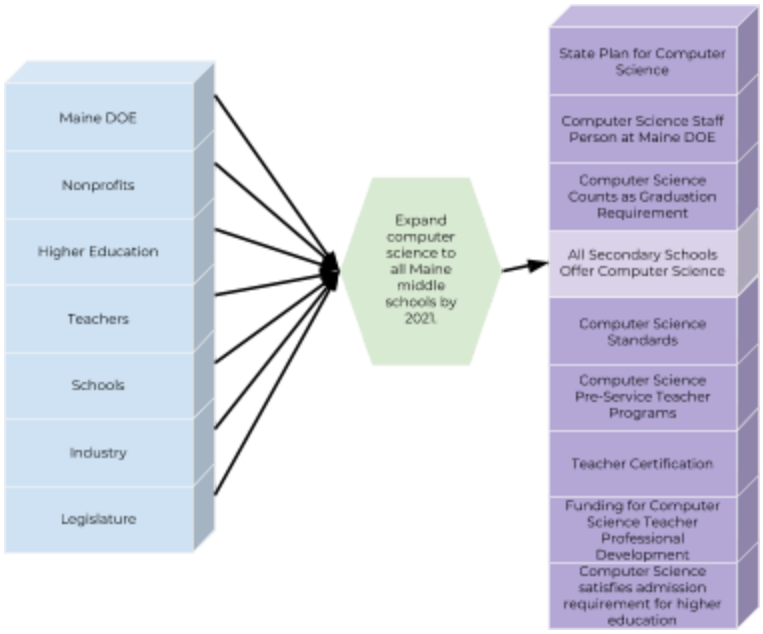
The K-12 CSTA Computer Science Standards should be used as the foundation for designing and adding computer science standards to the set of science standards. These standards were reviewed by the task force members and deemed appropriate to use as a foundation in Maine. The major focus areas of the standards include computing systems, networks and the internet, data and analysis, algorithms and programming, and the impacts of computing.

In addition to adding computer science standards to the science content area it is important to create supports for schools to help them understand the connections this subject has to many other subject areas. One of the goals of proficiency based education is that subject areas do not live in silos but are connected together to support learning across all the areas. Schools will need more support connecting computer science to existing content areas since computer science is a newer area for many schools.

One key way to support schools in adopting and implementing these standards is to give them access to resources which help demonstrate the connections between computer science and other content areas. These supports could be created by existing teachers, organizations, or the Maine Department of Education. They would include example lesson plans or projects which connect computer science to other subject areas. In addition it could include connections between computer science and standards in other subject areas.

Expand computer science to all Maine middle schools by 2021.

Maine middle school students are academically curious, engaged in learning, and open to new concepts. They are equipped with one-to-one computing devices thanks to the MLTI program and often have teachers who actively use technology to support their learning. Many Maine middle schools offer interdisciplinary teaching and learning to help students make connections between each content area. Middle school is often the time when students start to make choices about careers and consider what pathway they may select in high school and beyond.



With limited resources available, it is important to align resources to a common goal. The task force members agree that middle school is the most essential age for students to have access to computer science. By supporting an overall state goal, the State will prioritize computer science education and help align partners to help support the success of the goal. Currently, less than 20 middle schools in Maine offer computer science classes or integrated computer science classes to their students.

In order to have computer science at every middle school in Maine the state will need to invest in training middle school teachers to teach computer science. Each school will need someone on staff that is trained to teach computer science. Three years is not enough time to grow pre-service programs and train pre-service computer science teachers so other short term solutions will need to be used. Existing models of inservice teacher training support taking teachers from other subject areas and training them to teach computer

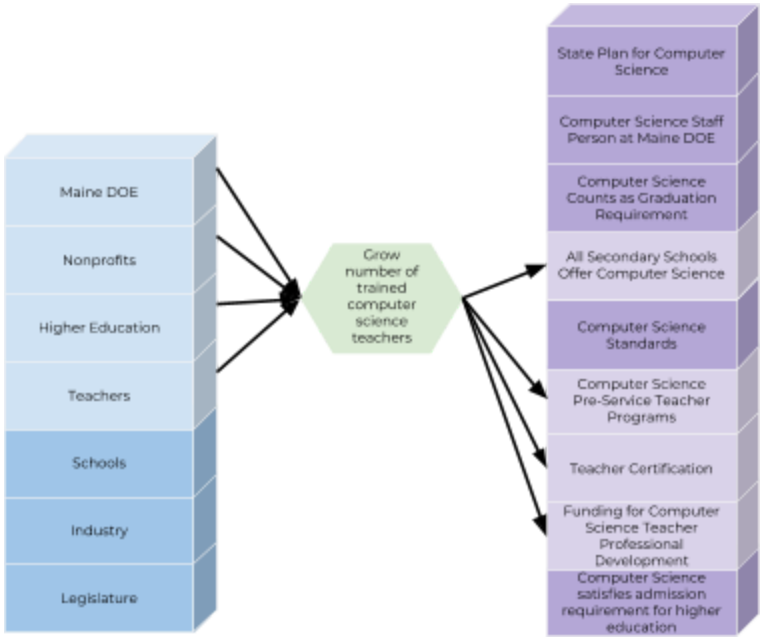
science courses. We recommend that this method of training be used to scale the opportunities in Maine quickly.

One avenue for adding computer science into middle school is through Career and Technical Education. As the new middle school CTE experience requirement is implemented, it is essential to recognize high quality computer science offerings at the middle school as one way for students to meet this requirement. Middle school computer science classes offer students hands-on skills needed for the workforce and an exploration of career pathways available in technology here in Maine.

By recognizing high quality computer science classes in middle school as potential CTE experiences, schools will be able to implement this requirement without much additional cost and provide access to career experiences essential to Maine's future economy.

Invest in growing the number of trained teachers for computer science.

Efforts to train computer science teachers in Maine are already underway but they are not enough to ensure equitable access to high quality computer science in all schools in Maine. In order to ensure high quality computer science for all Maine students, all Maine schools need to have trained computer science teachers. Maine will have to invest in training existing pre-service teachers.



The non-profit and higher education communities are working collaboratively to offer teacher professional development to support the teaching of computer science in Maine. With limited resources, the organizations have been able to train dozens of K-12 Maine teachers to teach computer science. In order to reach more schools, the professional development providers should collaborate with one another to focus on schools without computer science education. By prioritizing schools without computer science education, the providers will be able to leverage existing resources to help expand computer science throughout Maine.

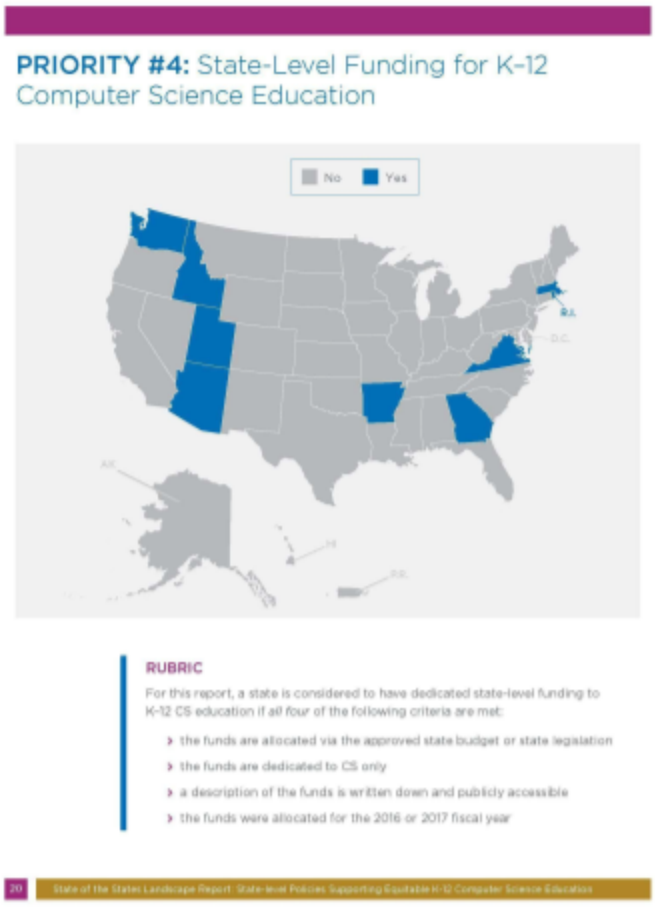
Middle school teachers have attended a variety of different professional development programs including Exploring Computer Science, Computer Science Discoveries, and LearnToMod through the University of Maine. Many of the current efforts in Maine to train computer science teachers use a similar model where teachers go through a 5 day summer experience, follow up school year workshops, and online support. The training is focused on getting teachers ready to teach one course using a specific curriculum. These trainings are a great way to scale the number of computer science teachers quickly.

It is important the the professional development offered to teachers is high quality. In order to ensure that it should follow national best practices around teacher professional development. The CSTA K-12 Computer Science Framework recommends the following best practices for computer science teacher professional development:

- Customize professional development to meet teachers' varied backgrounds in computer science. When a workshop of teachers from the same subject background is not possible, a workshop could include sessions for teachers to break into groups based on experience or certification.
- Professional development should attend to novice teachers' anxiety over their lack of content knowledge. Professional development can instill a growth mindset in participants, in which learning builds over time, during a workshop as well as the school year while teachers deliver instruction.
- Providers should connect professional development experiences to a curricular context. Professional development connected to the concepts and practices in the framework can provide opportunities to practice teaching content (i.e., microteaching) and can be contextualized to particular curricula that teachers will be using in their classrooms.
- Professional development should include a focus on increasing access and equity. Computer science brings unique issues that require the emphasis of particular pedagogical practices, such as equitable practices that address the varied exposure students have in computer science and stereotypes that exist about the field (Ryoo, Goode, & Margolis, 2016). The issue of equity in computer science is addressed more fully in the Equity in Computer Science Education chapter.
- Professional development should address the management of a productive computer lab environment. Teachers must learn how to manage a classroom in which the computer serves as both the primary medium for demonstrating performance as well as an occasional teaching aid.

The non-profits organizations currently training computer science teachers can't do it without funding though. Code.org estimates it takes about $6,000 dollars to train 1 new computer science teacher. With over 200 Maine middle schools and only a small number of trained middle school computer science teachers, it's going to take a 1.2 million dollar investment in order to train up the teachers needed to reach the goal of having computer science in all Maine middle schools by 2021. This invest should be broken up across the 3 years. This investment could be done through a grant program facilitated by the Maine Department of Education, the Maine STEM Council, or a similar nonpartisan organization.

A variety of other states have invested in computer science teacher professional development (The map to the right shows the states which had dedicated state funding for computer science as of March 2017). Arkansas has invested $10 million in ensuring every AK high school can offer computer science. Arizona has invested $700,000 to implement computer science K-12. Idaho has invested $4 million to expand computer science offerings. North Carolina has invested $800,000 to support computer science expansion efforts. Maine needs to invest in computer science professional development to make sure Maine students don't miss out on this important subject.



Source: State of the States Landscape Report (Resource 3)

However we should go beyond these efforts in the future and work to build up a core

of computer science teachers who have deep content knowledge. This will require the creation of a teacher certification or endorsement for computer science. Adding this certification will allow higher education institutions to design programs and pathways for pre-service computer science teachers. In addition it will allow future computer science teachers to be able to expand offerings beyond the specific courses they may have received professional development for.

As Maine looks to at teacher certification it will be important to consider how the people teaching computer science who came at the profession through different avenues can continue to teach. Existing computer science teachers should be given different opportunities to demonstrate their content and pedagogical knowledge. Such avenues could include allowing existing computer science teachers to take the new computer science Praxis exam, which is currently under development, to demonstrate their computer science knowledge. Another avenue is to recognize the rigorous professional development teachers have gone through for credit towards their certification. It is also important that time be given for this transition so that existing teachers who want to go for the certification but need to do extra course work will have the ability to while still teaching.

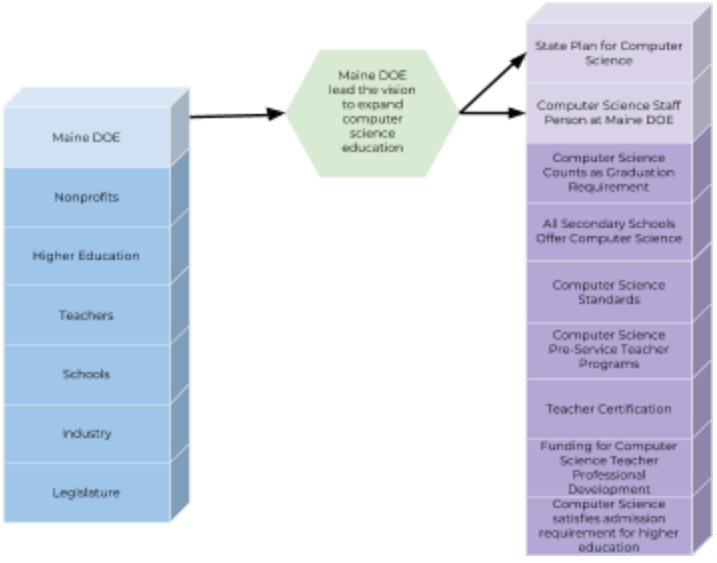
Currently, there is not a comprehensive teacher pathway for students interested in teaching computer science in Maine. As computer science offerings expand in K-12 schools, it is important to have a clear career pathway for aspiring computer science teachers.

Higher education institutions will also play a key role in growing the number of computer science teachers. Currently high education institutions offer robust computer science currently. Unfortunately these courses are not always accessible to pre-service teachers and even if they are most teachers don't know what computer science is. If someone is already interested in being a teacher efforts should be taken to give them background and the ability to teach multiple subjects. In Maine this will be key as many smaller schools in the state need their state to be able to fill multiple roles. One way to ensure pre-service teachers are aware of the importance of computer science is to integrate computer science courses into the required pathway for pre-service teachers.

Another avenue that higher education institutions can consider to expose more interested teachers to computer science is to add computer science to the technology education courses currently offered. Many of the pre-service teachers are already required to take at least one technology course as part of their undergraduate or graduate major. One way to expand computer science skills to more teachers is to integrate computer science units into the existing technology courses offered in the curriculum. The University of New England has piloted this approach by integrating computer science lessons into one of their technology courses, EDU 110: Supporting 21st Century Learning Through Technology.

The Maine Department of Education should lead the vision to expand computer science education in Maine through collaboration with the CS4ME Coalition and other supportive partners.

A statewide plan for computer science implementation is essential to guide the work of MDOE staff members, districts, and other stakeholders and to remain consistent when staff changes. Equitable access needs to be a central part of the statewide plan. The plan should include major policy areas, implementation details, funding priorities, and implementation timelines.



Rhode Island, Arkansas, and Connecticut are a few states who have implemented state plans to

guide their computer science education implementation.

There is wide support to expand computer science education in Maine and many willing volunteers to help provide examples, models, and feedback to help draft a state plan for computer science. A Maine Department of Education staff member assigned to computer science could lead the statewide planning process, advocate for the adoption of computer science standards within the science and technology standards, and help develop multiple pathways for preservice and inservice teachers to become computer science teachers.

Currently, there is no assigned Maine Department of Education staff person to computer science as a content area. Staff members are assigned to areas like science, mathematics, English language arts, and social studies. Without an assigned staff member, it is challenging to facilitate the expansion of computer science in Maine in collaboration with the Maine Department of Education. Schools with questions currently do not have a contact person and there is no staff member to work directly with teachers on computer science implementation. By assigning someone responsibility for computer science within the department, it will make collaboration on computer science expansion efforts more successful.

Arkansas, New Hampshire, Virginia, Oklahoma, Nevada, and Massachusetts are just a few examples of states who have created positions within the Departments of Education to coordinate computer science.

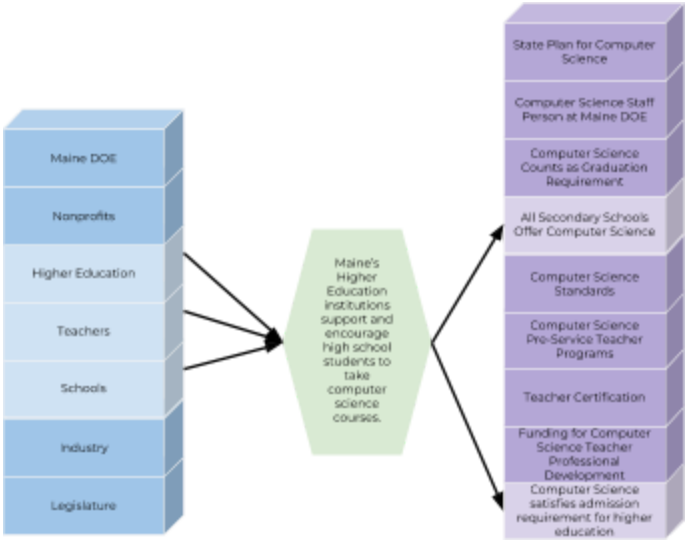
Funding for a position in the Maine Department of Education could be secured in two different ways. A current staff member/position could be assigned to computer science or a new position could be supported through the state budgeting process.

There is an existing plan and timeline for the Maine Department of Education (MDOE) to review potential new teacher certification and endorsement pathways. The MDOE will have conceptual conversations in the spring of 2018 regarding new pathways. It is essential this dialogue happens with members from the CS Task Force during the spring of 2018.

There is great concern that a new teacher certification pathway might not support existing computer science educators, so care must be taken to offer short-term and long-term options to ensure highly qualified teachers. A variety of current CS teachers hold the 680 teacher certification. It will be important for teachers with this certification to be able to transition to any new system appropriately.

Maine's Higher Education institutions should support and encourage high school students to take computer science courses.

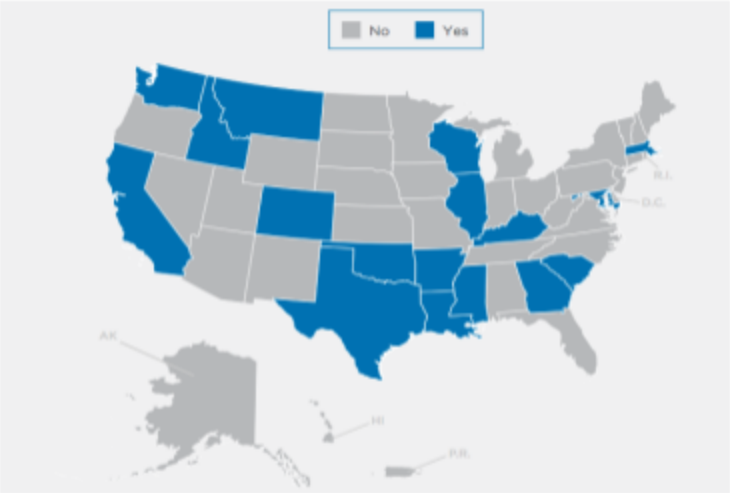
Currently, Maine higher education institutions do not have procedures to accept computer science as a core admissions requirement to replace a course like science or mathematics. As a result, computer science is treated as an elective course and given similar recognition as other elective courses. There are a few Maine colleges which encourage students to take computer science classes as part of their high school coursework. For example, the University of Maine encourages students to take computer science classes in high school.



Embracing the importance of computer science coursework is an example of where Maine high schools and colleges could collaborate in the best interests of the students and schools. If more Maine

high school students learn essential programming, computational thinking, and problem solving skills, they will be better prepared for rigorous coursework in college and more equipped for workforce demands. The relationships between high school guidance counselors and college admissions officers is pivotal to communicate appropriate career pathways for students and emphasize how valuable computer science classes are for students.

PRIORITY #10: Computer Science Can Satisfy a Core Admission Requirement at Postsecondary Institutions



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For this report, a state is considered to allow CS to satisfy a core admission requirement at postsecondary institutions if state policy or administrative guidelines allow CS to satisfy a required credit for admission at all public four-year postsecondary institutions in a state.

Source: State of the States Landscape Report (Resource 3)

Advanced Placement coursework is one way for high school students to demonstrate their skills during the college admissions process. Advanced Placement Computer Science A and Principles are accepted at Maine's public universities. If students attain a score of 3, 4, or 5 on the exams, advanced college credit is given to the student. This process is the same for many other AP courses. Taking AP coursework is looked at favorably by admissions staff, but it does not replace the requirements for high school mathematics, science, or other content areas.

The task force members recommend higher education institutions reexamine their policies and procedures regarding computer science coursework in high school. Computer science classes often offer the same level of rigor as other core subject areas and should be recognized in a similar fashion. Through partnership, high school staff and college admissions could significantly impact how many students take computer science classes in high school.

Maine has made a commitment to fund early college opportunities through recent investments in the expansion of early college programs at both community colleges and four-year institutions. Student participation in early college programs is at an all-time high, and students have been able to get many college credits while still attending high school.

Early college is a meaningful way for Maine high school students to get access to high quality computer science courses. Maine's colleges and universities already have a variety of computer science faculty members, but early college enrollment in computer science classes is low. By increasing early college opportunities in computer science, students can get college credit and access a variety of computer science classes at various institutions across Maine. Historically, the drawbacks of early college programs can include lack of qualified instructors, space in on-campus college courses, and restricted enrollment access often limited for students with high grades or other prerequisites. Maine colleges are working to address these challenges. Despite these barriers, early college and dual enrollment programs are an essential way to grow access to computer science classes for Maine students.

The University of Maine at Augusta offers high school students the opportunity to take computer science courses through their early college program. Maine high school students have accessed Introduction to Computer Apps, Introduction to Computer Science, Programming Fundamentals, Web Applications, and Introduction to Information System Security in the last few years. These opportunities are also available at other campuses at the University of Maine System.

Thomas College offers a dual-enrollment course entitled, Introduction to Computer Science. This course is taught by a high school teacher who has met particular requirements from Thomas College. For example, 17 Baxter Academy students are enrolled in the course this year.

At Husson University, high school students can enroll in the Early College Access Program (ECAP) and access up to two college courses during each semester onsite in Bangor, Westbrook, Presque Isle, or online. A variety of classes connected to computer science are available as long as students meet the appropriate pre-requisites.

Through a collaboration between the Maine Department of Education (MDOE) and the University of Maine at Fort Kent, any student in Maine is able to access AP Computer Science for free online through the MDOE's AP4ALL program.

Similar early college opportunities are available at a variety of Maine higher education institutions including the campuses of the University of Maine System, Husson University, University of New England, St. Joseph's College, Colby College, and campuses of the Maine Community College System.

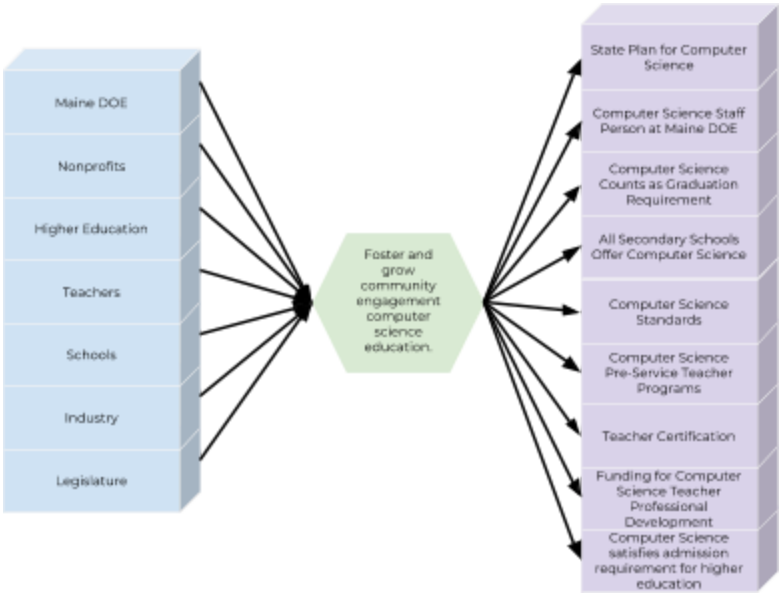
The University of Maine System is open to working collaboratively with the Maine Department of Education on additional early college models which target the expansion of K-12 computer science offerings and potentially teacher training.

In order to accomplish this recommendation appropriately, higher education institutions and high schools need to collaborate to offer computer science classes which can be access at no or low cost to high school students. High school guidance counselors need to be available to support student enrollment and make sure students are able to be successful in the early college courses. Higher education faculty need to be available to offer additional student support and be able to communicate a clear pathway into computer science-related careers.

High school students are often unaware of opportunities to take computer science classes through dual enrollment or early college programs. High schools, colleges, and supporting organizations should partner to better market these opportunities for students. High schools should consider working with cohorts of students to facilitate enrollment in computer science classes especially if high school computer science teachers are not available in their communities. Since there is a wide variety of challenging computer science classes available at Maine colleges, students can also pursue more advanced computer science courses which might not be available at the high schools. For example, if a high school junior thrives in AP Computer Science Principles, he or she could take a dual enrollment or early college course at a Maine college during his or her senior year in a more advanced computer science topic.

In order to increase the number of Maine high school students taking early college and dual enrollment offerings in computer science, colleges should develop clear computer science pathways for students to follow which align their career interests with appropriate coursework. For example, students interested in exploring a career in web development could take a set of introductory courses which offer both college credit and a better understanding of the knowledge and skills needed for a career as a web developer. This model could help students pursue rigorous coursework in high school while determining what pathway would be appropriate for post-secondary education.

Continue to foster and grow community engagement in expanding computer science education.



The Maine CS Task Force is comprised of 12 active members passionate about expanding computer science education to Maine students. These members represent a small portion of computer science advocates in Maine. In order to move forward to appropriately implement computer science education in Maine schools, stakeholders and volunteers need to come together to support the overall goals. This approach would allow more inclusion of stakeholders and provide long-stability for support for computer science. By forming a coalition of organizations which would include non-profit organizations, higher education institutions, K-12 schools, industry partners, and other supporters, Maine can make more progress by leveraging resources and promoting similar goals. The Coalition could help partners collaborate on grant applications and align strategies to support common goals. With the recent announcement of potential future funding through the United States Department of Education to support computer science education, it will be important for organizations and stakeholders to partner rather than compete for resources. This recommendation would not require legislation or additional funding but instead it would require organizations and other stakeholders to unite regarding common goals for Maine.

Many other states have used similar coalitions or new non-profit organizations to support K-12 computer science education efforts. Rhode Island formed CS4RI (https://www.cs4ri.org) as a coalition under Governor Gina Raimondo in 2016. As a result, the coalition works toward common goals to provide access to computer science for kindergarten through high school students. The group wants each RI high school student to have access to AP Computer Science classes as well. The coalition sees this work as a way to address equity and attract businesses to invest in Rhode Island. Texas has also formed a coalition to support the expansion of computer science (http://cs4tx.org). The state has a broad-based coalition with business leaders, parents, and educators working together to bring computer education to every student in Texas. To accomplish this goal, the coalition focuses on growing the grassroots community network, supporting high quality teacher professional development, and working directly with policymakers.

Computer Science Curriculum Providers By Grade

K-5	• Code.org Computer Science Fundamentals • Code Monkey • Code Red Education • Project Lead The Way • ScratchEd • Tynker
6-8	• LearnToMod • Code.org • Bootstrap • CodeHS • Code Monkey • Codesters • Globaloria • Project Lead The Way • Pythonroom • Scalable Game Design • ScratchEd • Tynker • UC Davis C-STEM.
9-12	• Exploring Computer Science • Code.org • Mobile CSP • Beauty and Joy of Computing • CodeHS • Bootstrap • Edhesive • Globaloria • NMSI • Project Lead The Way • ScratchEd • TEALS • UC Davis C-STEM • EdX • Coursera • The Virtual High School

Current Landscape of Maine K-12 Computer Science Education

Grades K-5

Code.org has a K-5 curriculum called Computer Science Fundamentals which offers free units and lessons to educators to implement computer science in their classrooms. 252 educators have been trained through 20 one-day workshops to teach CS Fundamentals in their schools. These units can be integrated within other content areas or taught separately as stand alone units in computer science classes. Elementary educators with a variety of specialities have implemented the Computer Science Fundamentals course. Library media specialists have used various computer science curricula to reach even more elementary school students at Maine schools.

Further data is need on other curriculums used in K-5 in Maine.

Grades 6-8

Middle schools have a variety of curriculum materials available to increase access to computer science. The University of Maine's Advanced Computing Group has a project through the National Science Foundation called "LearntoMod" using Minecraft to teach computer science both during the school day and after school environment. Currently, the University of Maine has partnered with 4 Maine districts including RSU 22, Bangor Schools, RSU 19, and Seacoast Rise Center to offer this curriculum.

Maine Mathematics and Science Alliance, in partnership with the University of Maine at Augusta and RSU 22/Orono School Department, has trained 56 middle and high school teachers in Exploring Computer Science. Although this course is primarily implemented in Maine high schools, some middle school teachers have also offered this course to middle school students.

In 2017, Maine Mathematics and Science Alliance, Educate Maine, and Code.org trained 14 teachers (reaching 1369 students) in Computer Science Discoveries. This course is appropriate for students in grades 6-10 and has been implemented at a variety of middle schools throughout Maine.

Example of robust computer science programs at Maine middle schools:

Lyman Moore Middle School in Portland currently has 90-95% of both grades six and seven enrolled Code.org's CS Discoveries (Units 1-3 this year) class. ⅓ of Grade Eight is currently enrolled in CS Discoveries (Unit 3) too. However, Grade Eight only has the course for one trimester before rotating. By the end of the 2017-2018 school year, 90-95% of Grade Eight will have had 2 ⅓ years of computer science before entering high school. The other 5%-10% will have had approximately one trimester to one year of computer science. Those students have been enrolled in reading intervention, math intervention or ELL courses. Next year's Grade 6 will have Units 1-3, Grade 7 will have Units 4-6 and Grade 8 will have Unit 5. The school will also have a 3D Design and Printing unit that the staff will be working on in May and in our after school STEM Club later this year. The total student population of Lyman Moore Middle School is approximately 500 students.

Grades 9-12

Maine high schools offer a variety of computer science courses from beginning programming classes to robotics to web page design. Since computer science proficiency is not required as part of the high school diploma, the high school offerings are often based on local preferences, teacher capacity, and student interest.

Maine Mathematics and Science Alliance, in partnership with the University of Maine at Augusta and RSU 22/Orono School Department, has trained 56 middle and high school teachers in Exploring Computer Science. This course is primarily targeted toward high school students.

In 2017, Maine Mathematics and Science Alliance, Educate Maine, and Code.org trained 19 teachers (reaching 391 students) in Computer Science Principles and 14 teachers (reaching 1369 in Computer Science Discoveries. Computer Science Principles is appropriate for students in grades 9-12 and has been implemented as an AP and non-AP class at a variety of high schools throughout Maine. Computer Science Discoveries is appropriate for students in grades 6-10 and has been implemented at a variety of middle schools throughout Maine.

AP Computer Science

The following high schools have gone through the AP Audit process to authorize AP Computer Science Principles this year:

- Falmouth High School
- Fryeburg Academy
- Hampden Academy
- Kennebunk High School
- Lincoln Academy
- Maine Central Institute
- Monmouth Academy
- Mount Desert Island High School
- Mountain Valley High School
- Old Town High School
- Poland Regional High School
- Presque Isle High School
- Richmond High School
- Sacopee Valley High School
- Vinalhaven School.

64 Maine high schools have gone through the AP Audit process to authorize AP Computer Science A this year. 246 Maine students took an AP Computer Science exam in 2017. Only 20% of these students were female; 8 students were Hispanic or Latino, 4 students were Black, and only 1 student was Native American or Alaska Native. In 2016/2017, 23 Maine high schools offered an AP Computer Science course.

Several Maine schools offer International Baccalaureate (IB) Diplomas to their high school students. Kennebunk High School offers a class called “Information Technology in a Global Society” as part of the menu of courses available for students pursuing the IB Diploma.

Many of Maine’s Career and Technical Education Centers have computer science-related programs. These centers include:

- Capital Area Technical Center
- United Technologies Center
- St. Croix Regional Technical Center
- Caribou Technology Center
- Waldo County Technical Center
- Tri-County Technical Center
- Foster Career and Technical Education Center
- St. John Valley Technology Center
- Lewiston Regional Technical Center
- Mid-Maine Technical Center
- Northern Penobscot Tech Region 3
- Regional 9 School of Applied Technology
- Oxford Hills Technical School (Region 11)
- Sanford Regional Technical Center
- Westbrook Regional Vocational Center

In addition, Maine CTE programs have strong articulation agreements with Maine’s community colleges which allows students who pass a credentialing exam to achieve college credit at the community college in a variety of computer science courses.

Examples of robust computer science programs at Maine high schools:

Baxter Academy for Technology and Science currently has 115 students enrolled in beginning and advanced CS classes and 56 students engaging in a CS-focused project on Fridays. Most of the CS projects focus on game design & development. Beginner classes use Python via CodeHS and Arduino with electronics applications. Advanced classes may use java, javascript, or HTML/CSS, depending on student interests. Game design & development typically use a Unity platform with C++ for additional coding.

Maine School of Science and Mathematics (MSSM) has a variety of computer science courses including introductory courses and advanced courses. MSSM offers the following courses: Web Development, Introduction of Programming and Algorithms, 3D Rendering and Animation, Creative Robotics, Data Structures and Algorithms, App Development, Game Development, and Topics in Software Engineering and Robotics.

Mt. Ararat High School offers Introduction to Coding (semester long course for 9-12 grades), Computer Science (year long for 9-12 graders who have completed Algebra I), and AP Computer Science (year long for 10-12 graders who have completed Computer Science).

John Bapst offers a comprehensive computer science program with a variety of classes accessible to diverse students. These courses include AP Computer Science A, C Programming, Artificial Intelligence, Network Programming, 2D Graphics Programming, 3D Graphics Programming, Linux Scripting, and Robotics I.

Student Challenges Available to Maine High School Students

In addition to in-school offerings, there are several student challenges connected to computer science which inspire students with hands-on coding challenges. Tyler Technologies facilitates the Maine App Challenge for high school students which has students design apps and recognizes them with college scholarship funding. Blue Ox Technologies has launched a similar app design contest for Maine students. Students in Maine also compete in a national app challenge, the Congressional App Challenge.

Virtual Course Offerings

AP4All from the MDOE currently only includes AP Computer Science A.

Maine Virtual Academy: Offers a series of high school computer science classes through the K12, Inc. IST Program. Students enrolled in MEVA may select these courses through the regular course selection process. Courses include Computer Literacy, Computer Fundamentals, C++ Programming, Programming I: VB.Net, Programming II: Java, Game Design, Web Design, and Computer Science. Students who are not enrolled in MEVA may access these courses for a fee through an individual K12 International account.

K-12

Hour of Code activities have been another way Maine schools have provided access to computer science. Often included as part of Computer Science Education Week in December, schools often set aside time to focus on computer science with all enrolled students. In 2017, 233 Maine schools participated in Hour of Code activities. Additionally, 83 schools in Maine hosted Family Code Night in December 2017, using Hour of Code materials from Code.org. This allowed an additional 1,271 kids and 785 adults to collaboratively learn about Computer Science.

Current Landscape of Maine Computer Science Professional Development

Preservice Training

Computer Science Methods Course	Maine Mathematics and Science Alliance and University of Maine at Augusta collaborated to offer Maine's first computer science methods course during the summer of 2017. EDU 392: Methods of Teaching Computer Science was taken by six Maine teachers. Interested teachers should be encouraged to take this course to learn more about best practices to teach computer science.
Updating Existing Technology Education Courses	Several higher education institutions are integrating computer science into existing technology education courses. The University of New England integrates several computer lessons into EDU 110: Supporting 21st Century Learning Through Technology. The University of Maine offers a course, EDT 531: Studio in Computing in Learning, which offers a strong foundation for computation thinking and the ability for students to experiment with computer science topics.

Inservice Professional Development

Educate Maine and Maine Mathematics and Science Alliance (Code.org Regional Partners)	Educate Maine and MMSA has provided professional development to 33 middle and high school teachers in Maine. Educate Maine and MMSA facilitate a series of professional development (PD) programs for grade-specific CS curriculum for teachers of grades 6-12. Summer Workshops - Each Professional Learning Program begins with an intensive, hands-on, in-person workshop providing foundational experiences with the curriculum. The summer workshop is the primary capacity-building experience for teachers prior to their first year of instruction. Participants will explore the curriculum and tools, consider and experiment with specific teaching strategies, and build a local community of teachers. Continuing In-Person Professional Development - Depending on the program, teachers will participate in up to four, in-person professional development workshops throughout the year. Workshops focus on building pedagogical strategies while also exploring the essential elements of each course. Saturday sessions also focus on continuing to build inquiry and equity into the classroom daily. Online Support - Each Professional Learning Program offers an array of optional online support for teachers throughout the year. Support includes tools, content, new resources, a community connection and further encouragement to explore the curriculum. The blended PD model embraces the importance of in-person, cooperative workshops and online and asynchronous components to provide an ongoing community and support when teachers are in the classroom. Over the course of 12 months, teachers participate in up to 57.5 hours of in-person training for the middle and high school courses.

K-5 One day workshops (Code.org)	Elementary school teachers can sign up for a free, high-quality professional development workshop from an experienced computer science facilitator. The workshop will provide an intro to computer science, pedagogy, overview of the online curriculum, teacher dashboard, and strategies for teaching "unplugged" classroom activities. Workshops last 6-7 hours and will prepare teachers to teach the Code Studio courses for grades K-5. These workshops are offered across Maine on Saturdays.
Exploring Computer Science	In 2014, the Maine Mathematics and Science Alliance proposed a project to a special solicitation of the National Science Foundation's STEM+C grant competition for grantees who had had a Math/Science Partnership (MSP). The STEM+C project, "CSE Expansion: Building Capacity for CS Teaching in A Rural State" was awarded in 2015. Under the leadership of Dr. Tom Keller, MMSA and its partners UMA and RSU 26/Orono School Department have introduced 56 middle and high school teachers to the Exploring Computer Science (ECS) curriculum. This has been done through a week-long institute and four follow up days of professional development, totaling some seventy contact hours. 56 teachers have been trained over the last three years.
University of Maine "Learn ToMod" Project	The University of Maine Advanced Computing Group has a National Science Foundation grant working with middle schools across Maine with a "LearnToMod" project focused on using Minecraft in schools. The staff will be recruiting additional teachers to take part in this project.

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