Computer Science Education in Maine in 2017

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Introduction

This paper reports the progress made in MMSA's programs focused on computer science since the May 2017 *Exploring Computer Science Education in Maine: 2014-2017* white paper (see mmsa.org/resources/publications/white-papers/). Much background is discussed in that paper that will not be repeated here. This paper was prepared to record the great deal of activity in computer science education that has occurred recently.

Computer science (CS) education continues to be an item of top level educational discussions in Maine. Two organizations are collaborating on the K-12 aspects of this: the Maine Mathematics and Science Alliance (MMSA) through both its National Science Foundation *Building Capacity for CS Teaching in a Rural State* project and its Reach Center program, and Educate Maine (EM) through its Project>Login program. In addition to their individual programmatic efforts, these two organizations have agreed to become Regional Professional Development Partners with Code.org.

I. Recent definitions of "computer science"

To many people, computer science means programming or coding. This very narrow assumption is erroneous and limits the true value of CS.

The US Department of Education has recently released a definition of CS that describes it more in everyday terms. Their definition is:

> Computer science means 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, Web sites, 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. (US ED)

The definition of CS used in the K-12 Computer Science Framework and in the Computer Science Teachers Association standards is:

"As the foundation for all computing, computer science is "the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications, and their impact on society."

Clearly, CS is much more than programming and involves problem solving through computational thinking. MMSA approaches the growth of computer science in the State of Maine with a curriculum integration mindset. We strongly believe that computer science should be integrated across the curriculum K-12 and not simply an elective or one class set aside and separated from other disciplines.

II. Learning opportunities and computer science education

A. Large K-12 student opportunities

We are providing support for implementation of three major curriculums across the state. Through the Regional Partnership with Code.org, MMSA and EM sponsor in-state professional development programming for the Code.org *Computer Science Discoveries* (CSD) curriculum and the Code.org *Advanced Placement Computer Science Principles* (AP CSP) curriculum. In July 2017, 32 Maine teachers attended a five-day summer TeacherCon in Philadelphia, engaging in the opening series of professional development activities in these two curriculums (14 teachers in CSD and 18 teachers in AP CSP). These teachers will attend four additional daylong workshops on Saturdays throughout the academic year to continue their preparation to teach and to solve problems with implementation issues.

Table 1. Teachers who attended Code.org professional development in 2017-2018

Computer Science Discoveries	AP Computer Science Principles
Bucksport Middle School Dedham School Falmouth Middle School Glenburn Elementary School Leonard Middle School (Old Town) Lyman Moore Middle School (Portland) Noble Middle School Orono High School Ridge View Community School (Dexter) Westbrook Middle School	Bucksport High School Caribou High School Deering High School (Portland) Falmouth High School Gray-New Gloucester High School Hampden Academy Mountain Valley High School (Rumford) Northern Penobscot Tech Region 3 (Lincoln) Oceanside High School (Rockland) Old Town High School Piscataquis Community High School (Guilford) Presque Isle High School Sacopee Valley High School (Hiram) Spruce Mountain High School (Jay) Tri-County Technical Center (Dexter) Windham High School Wiscasset High School

These workshops are facilitated by Code.org-approved teacher leader facilitators who have received additional training and work as a pair with the groups. All four of these facilitators either teach or are based in Maine. In addition, Maine has applied for an additional CSP facilitator slot since one of our current facilitators is under great demand.

This is the same model that has been used with the *Exploring Computer Science* (ECS) curriculum since the first Maine cohort in the 2014-2015 school year.

ECS is designed to be a college preparatory high school course and it is recommended that students have completed an Algebra course prior to enrolling. It has been our experience that Algebra as a subject is not required as much as a maturity of students who have reached this level of knowledge. ECS is built on a research-based model of inquiry, equity and CS principles. Typically, in Maine, ECS is used in middle and high schools.

Computer Science Discoveries is designed for grades 6 to 10, according to Code.org literature. *AP Computer Science Principles* is for grades 9 to 12.

It should be noted that this is a first foray into a course or test by the College Board that is not for the replacement of a beginning college student course. Typically, high school students take Advanced Placement exams to gain high enough scores for colleges to accept these test results for college credit. There are several curriculums that have been accepted by the College Board as sufficient preparation for this exam and the Code.org AP CSP is one of those.

The *AP Computer Science Principles* test was given for the first time in 2017. The results appear in the following table:

Table 2. AP Computer Science Principles results for Maine

Test score	All students	% of all students	Males	Females	Nation	% in nation
5	10	10.5	10	0	6,115	13.8
4	20	21	17	3	9,607	21.7
3	31	32.6	25	6	17,320	39.1
2	30	31.6	18	12	8,101	18.3
1	4	4.2	2	2	3,187	7.2
Total	**95**		**72**	**23**	**44,330**	
Mean	3.02		3.21	2.43		3.17

Maine had 95 students take the exam, of which 72 (76%) were males and 23 (24%) were females. In terms of performance, Maine males outscored females (mean of 3.21 compared to mean of 2.43), and Maine students, on average, had slightly lower scores than the national mean (Maine 3.02 compared to the nation at 3.17).

The Maine Department of Education has school-by-school results, but these are not being released to the public. These data would be helpful in knowing which schools had better performance and perhaps which curriculums, if taught with fidelity, lead to better results.

The College Board offers a traditional CS test, titled Computer Science A. The Maine results for student testing in 2017 follow:

Table 3. AP Computer Science A results for Maine

Test score	All students	% of all students	Males	Females	Nation	% in nation
5	21	13.9	16	5	14,623	24.2
4	29	19.2	24	5	12,650	20.9
3	38	25.1	34	4	13,271	21.9
2	18	11.9	14	4	6,970	11.5
1	45	29.8	37	8	13,005	21.5
Total	**151**		**125**	**26**	**60,579**	
Mean	2.75		2.74	2.81		3.15

B. Additional K-12 student opportunities

There are many other CS curriculums and programs being taught throughout the state by individual teachers. Code.org through its Regional Partners, MMSA and EM, has a program for grades K-5 teachers and students titled *Computer Science Fundamentals.* To date, Maine has had one CSF facilitator (Mike Harvey, Falmouth schools) and he has reached a large number of elementary teachers with this professional development. As of late fall, he had facilitated 21 CSF workshops over several years, with a total of 252 teachers attending. Maine has applied for a second CSF facilitator slot, to reach additional K-5 teachers across the state.

Many Maine teachers have developed their own curriculums on CS and computer technology-related topics. For example, Michael Murphy, at John Bapst High School in Bangor, has created an exceptionally strong CS program and offers courses in AP Computer Programming, Artificial Intelligence, Computer Programming, Cyber-Security Team, Engineering I & II, Robotics I & II, Student IT Help Desk, and Video Production Club.

C. Teacher data

The NEO data reporting system of the Maine Department of Education lists 170 K-12 “Computer and Information Sciences” classroom teachers. By means of comparison, the NEO system lists 2,137 classroom teachers of grades 6-12 “Life and Physical Sciences”.

III. Community of Practice

Teachers, especially those who teach in relative ‘content isolation’ such as the 170 teachers across the whole state of Maine who teach Computer and information Sciences, benefit from a community of practice in numerous ways. They can share lesson plans, discuss ways to improve instruction, talk about resources they have or wish they had, and support each other.

We are building a CS education community of practice at two levels; one being statewide with the Maine chapter of the Computer Science Teachers Association and a second among the three major professional development programs of the two Code.org programs and ECS.

The Maine CSTA group has recently undergone a leadership exchange and this has led to an increase in activities. Now the group holds Zoom conferences with board members and other chapter members. This group includes teachers, organizational representatives from Maine Robotics, MMSA, and EM, and higher education faculty. They maintain an active web presence and an active listserv. A Maine CSTA member (and MMSA staff member) was awarded a Google grant to attend a Google Leadership Summit that preceded the 2017 national CSTA conference in Baltimore. She made excellent contacts and returned with new ideas and energy. A Maine CSTA member recently attended a New England CSTA meeting held at UMass Lowell and connected with leaders from the other New England states and computer education support organizations such as Google, Project Lead The Way, and the Microsoft Foundation’s TEALS program.

Google has recently released a Request for Proposals from state CSTA chapters for funding of chapter activities. Maine intends to apply for these funds, due in mid-January 2018.

At a smaller grain size, MMSA and EM received funds from Google to support interactions and capacity building among the three major professional development programs of the two Code.org programs and ECS. EM and MMSA will deliberately mix these groups and foster cross-program sharing to help build a community of practice at four Saturday workshops and additional virtual sessions. Topics addressed will include ways to recruit underserved audiences, means of communicating between meetings, and connections to Maine’s CS-rich businesses and industries. EM will be especially helpful with this last objective since this is their broader focus.

In addition, EM has added K-12 teachers of CS to their Technology Community Meet-ups. The original intent of these meet-ups was to encourage cross-business innovation among Maine companies that are CS-rich and that has now been extended to help teachers understand the need and local demand for CS-competent students. This is a powerful blending and crossing of boundaries between education and workforce. Educate Maine holds these regionally throughout the state.

IV. Teacher Certification Pathways

As the result of efforts begun under MMSA's National Science Foundation grant and enhanced by the appointed Task Force on Computer Science Education, the Maine Department of Education is considering several ideas regarding teacher certification. The taskforce's current resolution is to more broadly distribute a clause in certification regulations Chapter 115, Part 1, Section 1.2 Scope of Requirements, A. Certifications, 5. Teachers of children in alternative education programs and teachers of courses for which there is no teacher endorsement shall hold a valid teacher certificate for the grade level at which they teach. Thus, teachers who are teaching subjects such as CS or STEM, by Department acclamation, need only a teacher certification for the grade level at which they teach.

This certainly appeals for its potential capacity to lower the barriers such that more, and hopefully all Maine students, will have the opportunity to study CS. It does, however, present an issue of quality control of those teachers teaching CS.

There is now a CS methods course being taught at the University of Maine at Augusta. One proposal that has been offered to the Maine Department of Education is the creation of a 'micro-credential' in CS which a teacher would obtain by taking a CS methods course OR documenting at least 70 hours of professional development in CS. This would lead to higher level of quality control, and could serve as an interim certification solution.

The Maine Department of Education is examining the possibility of an alternative pathway into CS teaching by accepting a number of years working in the CS industry – say eight years – as sufficient knowledge background and requiring a small number – say three – of college courses in topics such as educating the exceptional child and classroom management.

Certification is a critical issue that the Task Force on Computer Science Education will no doubt address.

The underpinnings of a discussion on certification in CS strikes to the heart of the educational philosophical argument on whether CS should be taught as a separate subject (Code.org has said this is the first new subject to be introduced into American schools in 100 years) or as an integrated one.

This has serious implications, especially in a rural state like Maine. If the bar of certification is set too high, many teachers will be unable to obtain this certification. And if certification is required, many small schools will not be able to recruit or employ certified teachers. This also runs counter to trying to integrate knowledge across content boundaries. The currently vogue designation of "STEM," meaning the integration of science, technology, engineering and math, is certainly a goal but full realization and attainment in the near future seems impossible. Small steps such as integrating science and math or science and CS are possible and better reflect the real world.

V. Connection of computer science education and business in Maine

These connections are made in several ways and are vital for both sectors. One way noted earlier was the Technology Meet-ups organized by Educate Maine.

A second is through the development of 6 (5 exist, 1 is under development) Maine-based lessons that align with the lesson units of *ECS*. Through these short videos and written lesson plans, Maine students are exposed to local businesspeople applying CS principles in their everyday work world. (https://mmsa.org/computer-science-resources/)

Career and Technical Education (CTE) constitute a third way that is not yet maximized. Currently there is a broad program name under CTE titled “Computer Repair/Installation”. These programs offer industry-recognized certifications and many have articulation agreements with Maine community colleges. The course for one such agreement provides credit for a student from Southern Maine Community College in CMIT 105 which is described as:

> This course gives students the technical skills and industry know-how required to install, configure, and troubleshoot computer networks. Topics include the OSI Model, TCP/IP, Ethernet, topologies, hardware, network design, wireless transmission, and security concepts. The course teaches toward the CompTIA's Network+ N10-005 certification exam. (http://burpee.smccme.edu/courses/syllabi/CMIT105syllabus.htm)

Expansion into areas other than computer repair seems like an obvious next step and is likely underway.

VI. Systemic Approach

The 128th Maine Legislature described a systemic approach to CS and sought a strategy for CS education with the establishment of a *Task Force To Recognize Computer Science in the Path to Proficiency*. This is a critical first step for Maine in advancing CS education. The report of this group, due to the Education and Cultural Affairs Committee by January 15, 2018, is meant to:

A. Identify the key elements of computer science education that provides mathematics or science competencies needed to attain a proficiency-based diploma;
B. Identify models of age-appropriate computer science curricula that provides students in kindergarten to grade 12 basic knowledge of and familiarity with computer science concepts and applications and opportunities to explore how computer science may serve their educational needs and career aspirations; and
C. Develop a sustainable professional development strategy to deliver kindergarten to grade 12 computer science education and to ensure that all students have access to computer science education. (LD 398)

This task force, chaired by Jason Judd of Educate Maine, has been meeting for several months to develop this strategy and report.

VII. Next steps

Several next steps seem critical to continue the momentum of increasing access to CS education for all Maine students.

1. Reviewing the report of the Task Force due January 15, 2018.
2. Disseminating the report of the Task Force to important people and groups in Maine such as the Maine CSTA chapter, ACTEM, the State Board of Education, MSTA, ATOMIM, MACTE, and MCLA.
3. Supporting development of the Maine CSTA chapter, in state, regionally, and nationally.
4. Continuing to build a CS educator community of practice.
5. Better connecting 2 year and 4-year higher education institutions and efforts with K-12, including CTE, and CS efforts.
6. Supporting continuing professional development of K-12 teachers of computer science.
7. Developing models of lessons that integrate CS principles with all other content areas.

VIII. Bibliography

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