Maine's STEM Education Landscape in Early 2019: Research to Support MSSM's Strategic Planning
January 2019

This report to the Maine School of Science and Mathematics (MSSM) Board of Trustees briefly outlines the current and projected state of middle and high school science, technology, engineering, and mathematics (STEM) education in Maine. We describe STEM schools and programs, distance education offerings, and educator professional development programs. The research included web searches, media articles, reports and data from state and national agencies and organizations, and interviews with seven key informants working in or knowledgeable about STEM education in Maine.

Background

MSSM was established by the Maine Legislature in 1995 as part of the State's effort both to strengthen its science and mathematics education programs and to use wisely the facilities made available by the closure of Loring Air Force Base in Limestone. It is Maine's only residential magnet school, annually serving about 150 high school students in its academic program and over 500 middle school students at its STEM summer camps. As MSSM nears its 25th year, under the leadership of a new Executive Director, it is undertaking a comprehensive strategic planning process to assess how best to achieve its mission in Maine's changing STEM-education landscape.

The growing importance of STEM sectors in the economy—and STEM skills in the workforce—has brought attention to STEM education nationally and in Maine in recent years. While math is one of the two most-tested school subjects, and sciences are taught at all levels, public education in technology and engineering are not well-developed. And despite significant attention on improving math and reading test scores over the past decade, student math proficiency levels in Maine and across the country remain around 30% to 40% at the elementary, middle, and high school levels.

> *"There's a huge opportunity and need in Maine schools for the higher-level math and science courses, but especially for technology and engineering."*
> Kim Quinn Hutchinson, Waterville Cyber Panthers

Starting earlier with stronger math and science instruction and more exposure to engineering and technology in elementary grades is a promising approach. Some national groups have developed and begun to study elementary STEM curricula. Initial findings suggest that certain classroom practices improve students' future academic performance. These include demonstrating the connections between engineering, science and math; teaching the engineering design process; and learning to gather information from failed attempts. Early exposure to engineering instruction also has a positive impact on interest in engineering jobs and skills for both boys and girls (Mind/Shift).

I.   Schools and K-12 Enrichment

STEM Academies and Public School Programs

Bangor High School
Bangor's Superintendent proposed the idea of a STEM Academy in 2011 and gave the high school science department chair and a chemistry teacher time off from teaching to design it. The school committee approved the plan later that year, and the STEM Academy began in fall 2012. Bangor High School enrolls 1,200 students in grades 9-12, and about 5% of them—60 to 65 students across the four grades—participate in the STEM Academy. Three cohorts of students have graduated, and although the Principal reports that there is some attrition, between 12 and 15 students have completed the program each year.

The course sequence for the STEM Academy (shown in the following image) includes a two-year Technology & Engineering course in which students learn the MATLAB programming language as sophomores, then develop and conduct research projects beginning in the summer after sophomore year and continuing for the junior year.

Bangor STEM Academy Course Sequence

	REQUIRED COURSE OR CORE ELECTIVE	SCIENCE	TECHNOLOGY & ENGINEERING	MATHEMATICS	RESEARCH
9th	English Geo-Civics Health & PE Language (and or) Fine Art	Introduction to Physics		STEM Algebra II & Precalculus [4 required courses at Honors or AP Level. Honors Geometry is Minimum Entry Course]	
Summer ➤					
10th	English PE Language or Fine Art [Potential for Elective Independent Study]	Select from: Honors Chemistry AP Chemistry AP Biology	Technology & Engineering I MATLAB and Analysis	AP Calculus AB	Introduction to Research Methods
Summer ➤					Begin Summer Research
11th	English US History Language (and or) Fine Art	AP Biology or AP Chemistry	Technology & Engineering II Computer Programming Application Writing	AP Calculus BC or Multivariable Calcululs	Continue research as necessary outside of school day
Summer ➤					Continue Summer Research
12th	English History Elective Language (and or) Fine Art	Select from: AP Physics AP Biology AP Chemistry Advanced Geostudies		Multivariable Calculus [Differential Equations proposed course in 2016]	Capstone Project Completed outside of school day

The University of Maine College of Engineering's associate dean collaborated in the development of the STEM Academy. Every student is assigned a faculty mentor to oversee their research project. Some mentors are high school faculty members, and some are UMaine engineering faculty members.

Cary James, the science department chair, says, "We believe students should enter juried competition as much as possible to do STEM. In our program, they have to enter the State Science Fair. We have many students compete in the Stockholm Junior Water competition. This way they improve and refine their projects, get really good feedback, they practice oral presentation and defense. We build kids from basic intro level to someone employers would want to hire by senior year."

Bangor High School Principal Paul Butler recommends that other Maine schools implement a two-year Technology & Engineering course like Bangor's, and that the state provide financial support to get that into as many schools as possible. He adds, "getting qualified teachers may be the biggest barrier. Our T&E teacher ran a lab at UMaine before this job. Schools will probably need to hire people who are not certified as teachers, who can work up to their certification."

Thornton Academy

Thornton Academy is one of 11 private high schools in Maine that enroll at least 60% publicly tuitioned students. Thornton began a STEM Pathway program in the fall of 2013. The program has three tracks: an applied STEM diploma (e.g., precision machining); a STEM endorsed diploma, and a Pre-Engineering track in which students can enter the University of Maine College of Engineering as sophomores. The STEM Pathway requires students to take at least ten courses: four or more in math, four or more in science, one or more in engineering, and one or more in technology. Two of the courses must be Advanced Placement or dual-enrollment.

Thornton has established an engineering laboratory on campus where students can pursue scientific design skills. The school's science department is in the process of shifting to "inquiry-based" instruction, a teaching method that combines the curiosity of students with the scientific method to enhance the development of critical thinking skills. The program includes job shadowing and internship experiences at Maine STEM businesses like Tyler Technologies. In 2017, the first two students completed the Pre-Engineering track and were accepted as sophomores at UMaine.

Waterville Cyber Panthers

The Harold Alfond Foundation has made a grant to Waterville Public Schools for the creation of a high school computer science curriculum. Working with the Center for Curriculum Redesign (CCR), the program is now in its planning year. Next fall, Waterville High School 9th graders will be the first students to enroll. The program hopes to enroll 40 students, one-third of the incoming freshman class. "Instead of just creating a computer science course, we are creating career pathways in computer science. There is an Intro to Computer Science course for freshman year, then in future years there will be a choice of courses throughout high school—cybersecurity, application development, coding, gaming, and virtual reality (VR)," says Executive Director Kim Quinn Hutchinson. "We took the code.org curriculum model as a base, and we compared it with national computer science education standards. We have a group of curriculum developers on our team, and they did

a crosswalk of those two models. Now they are filling in all those holes in developing our offerings. And they are looking at 21st century skills and integrating those."

Elements of the program design include:
- It is being developed and implemented by outside experts and funders in collaboration with the school.
- It is targeted to be accessible for all students. Organizers are paying attention to enrolling students underrepresented in STEM (girls, low-income students, racial/ethnic minorities).
- Robust partnerships are being built into the program ahead of time. Thomas College, Colby College and Kennebec Valley Community College are involved, as are industry partners like CGI, a national business and IT consulting firm with a new branch in Waterville. Community organization partners like the Waterville Boys & Girls Club will help the program to connect with younger students and extend into after-school time.
- The program is explicitly designed to serve as a model for other Maine school districts.

> *"Our program is saying—all kids can come in, there is no level of math prerequisite. Because you never know who is going to become inspired, get engaged by STEM, even if they have struggled in school in the past."*
>   Executive Director Kim Quinn Hutchinson

Baxter Academy for Technology and Science
Maine's first public charter school, Baxter Academy for Technology and Science in Portland, was established in 2013. Baxter serves Maine students in grades 9 through 12 and graduated its first class in 2016. Baxter describes itself as a rigorous, college-preparatory high school promoting student ownership of learning through a curriculum focused specifically on STEM. Students study complex, real-world problems, using and building technological tools in a collaborative environment with scientists, engineers and other professionals. Baxter serves students with strong interests in science, technology, engineering, and mathematics. They follow a standards-based, college-preparatory curriculum in English language arts, mathematics, science, social studies, and the arts. In 2017, the Maine Charter School Commission renewed Baxter's charter for ten years.

Enrollment
In 2017-18, 400 students from 59 towns in 38 Maine school districts enrolled at Baxter Academy, and the school had a waiting list of 26 students. Student characteristics include:
- 65% male; 35% female
- 19% special education
- 16% economically disadvantaged
- 89% white, 4% multiracial, 3% Hispanic, 2.5% black, and 2% Asian

Program
Baxter Academy has a new 32,000-square-foot, STEM-outfitted facility. Monday through Thursday, students participate in a core curriculum that offers choice among courses emphasizing science, technology, engineering, and math:

- 17 science courses including Forensics; Forest, Wetland & Marine Ecology; Immunology; Nuclear Chemistry & Electromagnetism; and Trophic Cascades
- Ten mathematics courses including Designing Statistical Studies and two years of Calculus
- A comprehensive engineering pathway of 22 courses including Engineering I, II, and Advanced Engineering
- Six technology courses (4 in computer science and 2 in electronics)
- Four years each of French, Mandarin, and Spanish
- Ten English courses including Advanced Public Speaking
- Eight design courses including Composites, Design Thinking, and Computer Aided Machining
- Nine art courses including Animation, two years of Graphic Design, and Digital Art
- 13 social studies courses including Advanced Public Policy, Entrepreneurship, and Personal Finance
- Four music courses and a theater performance course
- Five wellness courses including yoga

Every Friday, students participate in Baxter's Flex Friday program: student-managed, long-term projects working either individually or in groups. Students identify a real-world problem, define a solution, pitch their solution to a faculty review board, and develop and implement work plans including schedule, finances, outcomes, and connections to learning.

Baxter pursues community partnerships with organizations including Portland Public Schools, University of Southern Maine, and Maine Public. A dual enrollment partnership with Thomas College utilizes Baxter teachers to teach a college-level, credit-bearing Intro to Computer Science course on the high school campus. Seniors in Baxter's advanced engineering course work with Southworth Products (an advanced manufacturer in South Portland) to solve design problems. Baxter students have interned at Pika Energy, University of New England chemistry labs, art galleries, a veterinary clinic, and with the UNE athletic training program.

Recent and planned changes
Last year, Baxter introduced a Global Information Systems course that connects geometry, environmental science, technology, and the humanities, and a new course that teaches geometry through computer-aided design.

Baxter initially operated on a trimester system, but it transitioned to a semester model for 2018-19 to allow more students to pursue dual-enrollment college courses.

In 2019-20, Baxter's dual-enrollment Intro to Computer Science course with Thomas College (taught on site by Baxter faculty) will be offered to first-year students as the first course in the computer science sequence.

Performance Measures

Baxter students outperformed the state averages on assessment tests in English, math and science last year, as shown below.

11th Graders Scoring Proficient on the State Assessment (SAT), 2017-18

	Baxter Academy	State average
English Language Arts	80%	57%
Mathematics	45%	35%
Science	71%	48%

Other performance measures for 2017-18 include:
- Average Daily Attendance (ADA) of 94.5% was 2% higher than the state average for high school ADA of 92.6%. The target is to exceed the state average by at least 1%.
- Student intent to return for the next year: 91%. Target is 90%.
- Continuous enrollment of students for multiple years: 96% of students maintained continuous enrollment for more than one year. Target is 90%.
- 26% of juniors and seniors took dual-enrollment classes in 2017-18, up from 13% in 2016-17.
- Baxter's 4-year graduation rate in 2018 was 96%. Of the 2018 graduating class, 73% of Baxter's graduating students intended to enroll in a postsecondary institution; 17% intended to pursue full-time employment; and 10% expected to start or continue businesses.

Finances

As a public charter school, Baxter receives a per-pupil allocation from the school administrative unit (SAU) in which every Baxter student resides, which the SAU pays from state and local funds. The school also receives proportional funding for transportation and special education. The Maine Department of Education projects that Baxter's state and local funding allocation for 2018-19 will be $4.33 million.

Baxter's 2017-18 monitoring report indicated that it has maintained a positive cash balance and has not needed to access its line of credit. Due to expansion efforts and focus on "right-sizing" academic salaries, the school budgeted for a small deficit for 2018. Performance is consistent with budget, and cash flow remains healthy. Parents continue to show their support—15% made financial contributions through Baxter's annual appeal, and more make in-kind donations of time, expertise, materials and supplies for student activities.

Staff

12 Administrators: Executive Director, Principal of Students and Curriculum, Principal of Faculty and Instruction, Operations/Business/HR Manager, IT Manager, Front Office Manager, Student Services Coordinator/Admissions Manager, Partnership & Outreach Coordinator, Special Education Director and Assistant Director, Administrative Assistant, Special Education Administrative Assistant & Ed Tech

3 Clinicians: Speech & Language Pathologist, Guidance Counselor, Social Worker

30 Faculty: 10 Humanities, 5 Mathematics, 5 Science, 4 Special Education, 3 Art/Design, 1 Health, 1 Fabrication, 1 Computer Design

Governance
Baxter Academy's Board of Directors consists of "seven professionals who serve as a vital resource for expertise in school finance, educational best practice, development, assessment, business management, school operations, and the STEM industry in Maine." The school gets its charter to operate as a Maine public school from the Maine Charter School Commission, which is responsible for academic and operational accountability oversight and monitoring to ensure legal compliance with state and federal laws, rules and regulations.

Enrichment Programs

"Engage students in the connection to STEM careers at an earlier age. Make it clear to students how the class work connects to potential careers…Career exposure needs to start before high school."
Jason Judd, Project Login at Educate Maine

Consider Engineering
The University of Maine Pulp and Paper Foundation in Orono is a nonprofit established in 1952. The Foundation's mission is to support the research and workforce needs of pulp and paper industry by supporting teaching, study, and research at UMaine in industry-relevant engineering and technology.

The Foundation encourages high school and college students to consider engineering and technology studies at UMaine and leadership careers in the industry, with a goal of producing a pool of qualified, motivated graduates available to meet the entry level engineering needs of the industry and its suppliers each year. According to the Foundation, pulp and paper companies have more jobs and opportunities for technically trained people than can be filled by today's supply of available, trained engineers. The Foundation grants four-year merit-based scholarships to up to 90 UMaine engineering, engineering technology, and forestry management students.

Consider Engineering is a summer program offered annually to high school students who have completed their junior year and excel in math and science. The four-day camp on the Orono campus exposes participants to college life and technical careers. Students participate in over 20 activities with UMaine faculty, engineers, and engineering students. The program activities involve exploration of personal values, engineering experiments, discussions with UMaine staff, and problem-solving challenges, all designed to stimulate participants' intuition and reasoning ability. Participants work both independently and cooperatively to learn skills and then apply them to real life problems.

Consider Engineering is free to participants, but admission is competitive; about 50% of applicants are selected to participate each year. The program is offered in three one-week segments in July. Thirty-four high school students attend each week, for a total of 102 students each summer. In 2017, about 80 Consider Engineering participants (78%) applied

for a UMaine engineering studies scholarship. The Foundation reports that 100% of scholarship recipients who complete an engineering degree are either employed by the industry or attend graduate school.

For 2017, the Foundation reported total operating support and revenue of $1.377 million and net operating support and revenue of about $259,000. The Foundation had net investment income of about $3.3 million from about $24.9 million in net assets.

Jackson Labs

The Jackson Laboratory, with headquarters in Bar Harbor, Maine and operations in Ellsworth, Maine; Farmington, Connecticut; and Sacramento, California; is a nonprofit established in 1929. Jackson Labs engages in biomedical research, with a vision of understanding and stopping the conditions and diseases that undermine human health. The organization also educates current and future scientists and seeks to empower the global biomedical community by providing critical resources, data, tools and services.

The Jackson Labs Genetics Laboratory, with a 43-acre campus and over 1,500 staff, is Downeast Maine's largest employer, including more than 200 researchers, physicians, and veterinarians who staff and support the research teams that investigate the genetic basis of cancer, diabetes, Alzheimer's and many other human diseases and disorders. In 2017, it had operating revenue of $327 million.

The Genetics Laboratory and a Genomic Laboratory in Connecticut jointly conduct a Summer Student Program, a mentored independent research experience designed for undergraduate and high school students to immerse themselves in genetics and genomics research. It emphasizes laboratory discovery, communication of knowledge, and professional growth. A diverse group of students are chosen from all over the United States. They meet and connect with research-focused students from different backgrounds in a program designed to form a community of motivated science scholars and fellow students who are interested in different aspects of science.

Students participate in an ongoing research program with the support of an experienced scientific mentor. They develop an independent project, implement their plan, analyze the data, and report the results. At the end of the summer, they present their findings to researchers, other students, and parents. Admission is competitive, with an annual application deadline in February.

The lab's Genomic Education team offer fellowships to students who best match its programmatic goals and review criteria, which include a deep desire to conduct an independent research project and research interests that fit a project in the mentor's lab. The program seeks to admit a diverse group of students from a wide range of backgrounds and experiences, including students from disadvantaged socioeconomic and educational backgrounds, first-generation students, and individuals with disabilities. About 35 students attend the Summer Student Program in Maine each year. Summer Student Program participants receive a stipend of $5,250 for the 10-week program, including room and

board. The cost of round-trip travel between the student's home and the Laboratory is also provided.

Lewiston Public Schools Coding Initiative
Lewiston Schools have made a commitment to provide 50% of students with a coding experience by June 2019 through a $300,000, two-year grant from two Maine businessmen, David Roux of Jackson Labs and Corson Ellis, founder of Kepware. The district has hired a Coding Initiative Coordinator and convened a Coding Committee of elementary, middle, and high school educators. Two Family Code Nights for K-12 students have drawn more than 400 families. Code Night activities include a race between ozobots (small robots) for grades 3-6; Lego robotics for kindergarten and above; programming drones for eighth-graders and upper grades; and designing a Star Wars droids game for second-graders and those in upper grades.

This March, Lewiston's Coding Committee will host a Strategic CSforALL Resource & Implementation Planning Tool (SCRIPT) workshop. Computer Science for All is a national organization with the goal of equipping all students with computational thinking skills. A SCRIPT workshop helps districts define their values for computer science, evaluate existing programs, and design a rigorous, sustainable plan for K-12 computer science. The Initiative is offering professional development workshops and code.org curricula to district teachers at all levels.

Robotics Teams
One of the main ways some students are getting exposure to engineering is through extracurricular robotics teams offered after school. There are at least two statewide organizations supporting robotics: the MaineFIRST Robotics Leagues—with teams from 29 high schools—and Maine First LEGO, which is associated with Maine Robotics. There are several robotics competitions: First Robotics, First Lego League, and Robot Track Meets. Teams compete within Maine and New England, and top finishers win the opportunity to advance to national meets.

Maine Robotics is a nonprofit organization with the mission of bringing robotics to Maine students at all levels through school year enrichment and summer camp programs. It offers one-week camps in 3-D Design and Printing, Build Your Own Computer, LEGO Robotics, and Programming Minecraft to 12- to 16-year-olds, and a STEM Camp for 6- to 8-year-olds, at sites in Greater Bangor, Central Maine, and Greater Portland.

II.   Distance Education

> *"Especially in middle school, there needs to be high faculty engagement with students in distance courses. The courses need to offer hands-on learning and problem-solving, and not just have the students passively watching lectures—that's what makes distance learning not work…. It's challenging to do high-quality STEM virtually, but we have to keep working to develop and offer good models."*
> Jason Judd, Project Login

Key informants interviewed for this project expressed conflicting opinions about the promise of distance education for improving the quality and accessibility of STEM education in Maine. Skeptics named the challenges of using best STEM teaching practices in a virtual environment and a lack of broadband access in some parts of the state as barriers. Shari Templeton of the Maine Department of Education says, "Another big need is broadband access in many parts of the state. That, and limited hardware access in some places, limits the potential for distance learning to be able to address the teacher shortage, or provide high quality instruction to more students." And both she and Susan McKay of the RISE Center expressed trepidation about the effectiveness of virtual STEM courses. McKay said, "STEM poses some difficult problems for distance learning, because hands-on learning and the discourse aspect of it are so important to those disciplines. You might have to draw something…or do a lab experiment together with a group of other students. Some of the fundamental STEM teaching best practices are difficult to integrate over distance."

On the other hand, distance learning proponents discussed its benefits for individualizing instruction and the potential of bringing STEM courses to places where offering them in-person may not be economical. Seth Laliberte, Rangeley's high school math teacher, says, "Open scheduling is the big advantage. Students can work in study halls, at home, whenever they have time. They really like being able to earn college credit. The way education is going now, kids are not used to sitting and listening in a lecture class. They like self-pacing. Kids are learning very independently now. It took me a few years to accept it." Kim Quinn Hutchinson of Waterville's Cyber Panthers initiative adds, "Now that the technology for providing course instruction over distance has grown, we need to offer more online courses in public schools. It can be asynchronous, and with the right supports in place, online courses can be effective. You need a blended model where students can watch video lectures and examples and do some of their work at any time, but they also interface with teachers online or in person when they need extra support."

Maine Connections Academy
Maine Connections Academy (MCA) is virtual public charter school serving middle and high school students from more than 100 Maine school districts. Its mission is "to help each student maximize his or her potential and meet the highest performance standards through a uniquely individualized learning program in grades 7-12 throughout the state of Maine for students who need an alternative to the traditional classroom." The vision of MCA is to reach students for whom a cutting-edge virtual approach provides the very best pathway to school success by combining the best in virtual education with very real

connections among students, family, teachers, and the community to promote academic and emotional success for every learner.

Founded in 2014, MCA's charter was renewed for an additional five years in 2018. The school uses educational services from Maryland-based Connections Academy, which is owned by Pearson PLC, a multinational corporation that formulates standardized tests and publishes textbooks. Connections Academy provides an online system for students, administrators and teachers—including lesson plans, class lectures, daily student planners and checklists, and an intranet for announcements. Tracking data gives the teachers details about student activities like how long they were logged in, assignment status, and practice quiz scores.

Maine Connections Academy teachers work on-site at the school's South Portland office, attend staff meetings, and participate in professional development. Each teacher sets a schedule for live video lessons with students and student phone conferences to review work or discuss new material. The Connections software sets up lesson preparation, so teachers don't have to spend a lot of time on planning. Each student has a learning coach, usually a parent, and communications between the teacher and the coach are tracked.

Enrollment
In 2016-17, MCA enrolled 408 students from 108 school districts, up from 390 students in 2015-16.
- 60% of students were female and 40% were male.
- 23% of students were in grades 7 and 8, and 77% were in the high school grades. Of high schoolers, 29% were in 9th, 32% in 10th, 24% in 11th, and 16% were in 12th grade.
- 49% were eligible for free/reduced-priced school meals.
- 15% were eligible for special education services.

Program
Maine-based teachers cover a full range of typical middle and high courses in math, science, English, and social studies. Electives in varied topics like art, technology, and world languages are taught by Connections Academy teachers located outside Maine. Technology course topics include Animation, Computer Modeling, Computer Science, Engineering & Technology, Game Design, and Web Design. Other electives include Accounting, Business Information Systems, Law, Psychology, Sociology, Research Methods, and Sports Management. MCA offers many Advanced Placement (AP) course, and in 2016-17 the school began offering dual credit college courses in partnership with the University of Maine at Fort Kent.

Extracurricular activities at MCA include career and debate clubs, field trips, an annual academic summit, and an end-of-year celebration to facilitate student and family connections.

Governance and Funding
Maine Connections Academy receives about $4.04 million in student tuition from the SAUs in which its students reside, and it pays 55% of that to Connections Academy for education

services. The school's Board of Directors is responsible for fiscal oversight and hiring staff. The school has an external financial audit each year.

Performance measures
MCA developed academic proficiency targets of at least two percentage points of growth in the share of students meeting state academic targets from year to year.
- In 2016, 53% of MCA students were at or above state expectations in English Language Arts; the proportion increased to 61% in 2017, an improvement of 8 points—exceeding the target. By comparison, the percentage of all Maine students at or above state expectations was 51% in 2016 and 53% in 2017.
- In math, the share of students meeting state standards fell from 34% in 2016 to 29% in 2017. MCA did not meet its target. The percentage of all Maine students at or above state expectations was 38% in 2016 and 39% in 2017.

Other performance measures include:
- The school set average daily attendance rates of 93% for middle school students and 92% for high school students. Middle school attendance of 96% exceeded the target, but high school attendance of 91% fell just short.
- MCA exceeded its within-year retention rate of 70%, with an actual rate of 85%. The target of 50% year-to-year re-enrollment was also exceeded, with an actual rate of 87%.
- 96% of the class of 2017 graduated within four years, exceeding the target graduation rate of 90%. 55% of students earned dual enrollment college credit. 46% of graduates were accepted to college.

Maine Virtual Academy
Founded in 2015, Maine Virtual Academy (MEVA) is the second Maine public charter school with a distance learning model. Its mission is to develop each student's full potential with learner-centered instruction, research-based curriculum, and educational tools and resources to provide a high-quality learning experience for grade 7-12 students in need of alternative educational options.

MEVA's educational services are provided by the Georgia-based vendor K12 Inc., and the school has offices in Augusta. It uses a platform called Online School, loans each student a computer system, and delivers books, CDs, and science lab supplies to students' homes. Qualifying families can receive a stipend to pay for internet service.

Enrollment
In 2017-18, MEVA had 390 students from 105 sending districts enrolled and a waiting list of 202 students. Student characteristics include:
- 7% in 7th grade, 12% in 8th grade, 13% in 9th grade, 22% in 10th grade, 25% in 11th grade, and 21% in 12th grade.
- 60% female; 40% female
- 15% special education
- 61% economically disadvantaged
- 91% white, 6% multiracial, 1% Hispanic, 1% black, and 1% Native American

- 0.5% English learners

Program

MEVA develops an Individualized Learning Plan (ILP) with specific learning goals to meet each student's needs. Maine-certified teachers teach English, math, science and social studies classes. In these subjects, MEVA offers students four levels:
- Core courses are similar to standard high school courses and meet graduation and college admission requirements.
- Comprehensive courses are designed for students entering with a strong foundational knowledge and aptitude who have strong study skills.
- Honors courses demand even greater independence and self-discipline than Comprehensive courses.
- Advanced Placement (AP) courses are college-level courses that follow curriculum specified by the College Board and require strong self-discipline for in-depth study.

MEVA offers field trips, open house gatherings, social events, and clubs to help students connect in-person.

Performance Measures

MEVA Student Scoring Proficient on the Maine Educational Assessment, 2017-18

	Actual	Target
7th Grade English Language Arts	33%	46%
7th Grade Mathematics	19%	23%
8th Grade English Language Arts	42%	49%
8th Grade Mathematics	16%	14%
8th Grade Science	50%	69%
11th Grade English Language Arts	46%	59%
11th Grade Mathematics	8%	28%
11th Grade Science	31%	45%

Other performance measures for 2017-18 include:
- Average Daily Attendance (ADA) of was 88%, just missing the target of 89%.
- Student intent to return for the next year:
- Enrollment: 80% of students remained enrolled all year, exceeding the target of 75%. 91% of students reenrolled for the next year, just above the target of 90%.
- 49% of students graduated within four years, below the target of 62%.
- Among graduates, 80% planned to continue their education (76% is the target), 40% were accepted to college (37% is the target), 15% planned to work, and 5% entered the military.

The school's annual monitoring report states, "MEVA is striving to improve its academic outcomes, to provide differentiated courses and lessons for diverse learners, and to create opportunities for students to collaborate by offering each other academic feedback within our virtual classrooms. MEVA is working to prepare its students for higher education and

careers by facilitating/developing 21st century skills such as critical thinking, problem solving, and self-direction."

Governance and Funding
MEVA's state and local funding allocation for 2018-19 is $3.93 million. MEVA is governed by a Board of Directors composed of local community leaders, parents, and educators. The Board provides oversight on strategy, academics, staffing, and vendor management. It meets monthly, and all meeting agendas and minutes are made available to the public. The school's administration includes a CEO/Special Education Coordinator and a Programs and Operations Manager.

University of Maine Academ-e
The University of Maine developed the Academ-e program in 2006 to offer online early college courses to Maine high school and homeschooled students. The program makes it possible for students to take internet-based UMaine courses for dual high school and transferable college credit. Academ-e offers courses in mathematics, sciences, arts, humanities, and social sciences. Students can be nominated by high school principals, teachers, school counselors, or parents to participate in Academ-e.

Faculty can use a range of distance learning tools including Blackboard, Google Apps for Education, Zoom, and Kaltura Media Space for instruction, class discussions, and assignments. Students get a "Maine Street" account and a UMaine System email address to manage communications. A part-time student intern supports Academ-e students with resolving technical issues, providing referrals to tutoring and other campus service, and offering advice on time management and other challenges.

Academ-e courses cost students $25 per credit ($75 for a typical course), and the program is capped at 12 credits per student per year. The University discounts tuition 50% and waives fees, and the Maine Department of Education's Aspirations program covers the other 50% of tuition.

Student headcount enrollment in Academ-e courses over the past four semesters has averaged 120 students, with a high of 135 students in spring 2018.

UMFK Rural U
The University of Maine at Fort Kent also offers online early college courses to students across the state. UMFK's program focuses on recruiting rural students and aims to increase their access to academically rigorous and career-related courses, with the goal of boosting college and career aspirations and improving preparation. Rural U offers courses in nursing and health care, behavioral science and human services, criminal justice and public safety, forestry, and business.

Rural U is designed with a "high-touch" student support and service model, featuring responsive communication with students and administrators at their schools. Funding for

Rural U is like UMaine's Academ-e program, with the University waiving 50% of tuition, the state paying the other 50%, and students paying a per-course fee of $84.

The University of Maine Office of Institutional Research reports headcount enrollment in dual-enrollment courses (in-person and online) at UMFK averaged 576 students per semester from fall 2016 to spring 2018. The *Portland Press Herald* reported that, in fall 2018, about 700 students enrolled in Rural U courses.

III.   STEM Professional Development

> *"We really need growth in the qualifications of teachers who are teaching STEM, and in the number of well-trained STEM educators."*
>   --Jason Judd, Project Login

Gulf of Maine Research Institute
The Gulf of Maine Research Institute (GMRI) in Portland is a nonprofit established in 1968. GMRI pursues solutions to global ocean challenges and is dedicated to the resilience of the Gulf of Maine ecosystem and the communities and fisheries that depend on it. GMRI conducts scientific research on fisheries, invasive species and climate change, and cultivates science literacy. GMRI's 44,000 square foot marine research and education laboratory opened in 2005. The facility includes wet labs, analytical labs, office suites, conference rooms, and the Sam L. Cohen Center for Interactive Learning.

GMRI's annual budget exceeds $10 million. Its funding comes from state, federal, and foundation grants and charitable donations. GMRI has a CEO and a Board of 22 Directors. Its website lists 72 staff members. Many are scientists, and there at least 12 staff members dedicated to curriculum development and education partnerships.

GMRI believes whatever career path students eventually choose, engaging them with STEM subjects is one of the most important things it can do to ensure their success in an increasingly complex world. The skills students develop while studying STEM subjects are important to becoming effective citizens and successful professionals. GRMI believes problem-solving, critical thinking, communicating effectively, and collaborating within teams are universal and essential skills.

GMRI has established two learning environments for Maine students and educators, Vital Signs and Lab Venture.

Vital Signs is a community of middle school students, educators, professional and citizen scientists working together to collect, analyze, and share information about freshwater, coastal, and upland habitats. Students use inquiry, peer review, and scientific tools to investigate research questions, and social networking tools facilitate knowledge exchange between novice and expert. The goal is to transform students' relationship with science from distant spectator to thoughtful participant. Vital Signs uses a one-to-one statewide

computing network and social networking tools to connect all teachers and students to the Vital Signs community, including experts and scientists. Students use inquiry, peer review, and scientific tools to investigate a research question.

Vital Signs resources include professional development institutes, educator training, and development of complementary classroom curriculum and science standards. The Vital Signs website provides how-to guides, fieldwork toolkits, field mission guides, and classroom lessons. In 2016-17, the Vital Signs team engaged 95 teachers from communities across Maine in professional development trainings and workshops.

Building on the strong impact of a recent workshop on scientific argumentation, Vital Signs developed a series of "Next Steps" trainings to improve teacher skills and confidence in key content areas, including data analysis, biodiversity, and hands-on investigations.

LabVenture transports roughly 10,000 Maine 5th and 6th graders and their teachers to GMRI's Cohen Center for small group experiences of interactive science learning and exploration of the Gulf of Maine. The program also extends this experience back into the classroom by providing teacher professional development opportunities and curriculum resources.

In LabVenture, students and teachers experience firsthand the work of scientists. This immersive experience challenges students to solve problems collaboratively, collect data, reason with evidence, hone their ideas, and reflect on what they have learned. They work on real research questions that GMRI's scientists are looking into—questions scientist don't yet know the answers to. The LabVenture experience is designed to inspire students and teachers to think of themselves as scientists.

Maine Mathematics and Science Alliance
MMSA is a nonprofit organization formed in 1993. Its core mission is to find inspiring new ways to get people excited about science, technology, engineering and math, so that our youth can become the innovators and workforce of tomorrow. MMSA supports educators to teach science, technology, engineering and math in more meaningful ways. The organization offers consulting and coaching services to schools and hosts workshops and events. Its website states, "MMSA has developed a regional workshop model, where staff provide professional development to groups at low cost. We work throughout Maine and across the country."

Executive Director Ruth Kermish-Allen says, "We do three main things: 1) Our core work is professional development for PreK-12 educators, both in and outside the classroom—also in after-school programs, environmental learning centers, YMCAs, and other providers. 2) We do research and evaluation of our own programs, and our partners' work—like GMRI or Hurricane Island. We help them collect and evaluate data and identify their programs' outcomes. 3) We work to set up networks and systemic change initiatives—like the Governor's cabinet—to understand all our STEM partners, help them understand one another, and keep communications flowing in Maine STEM education."

Kermish-Allen describes the challenges of offering STEM professional development in Maine as follows: "There is not a lot of consistency to the type of STEM education students across the state are getting. It depends too much on school district budgets and what local taxpayers are willing to support. It's been difficult to provide professional development that works for all Maine educators. We've had to figure out remote professional development, high-touch and low-touch options… At MMSA we've been trying to level the playing field by going for grants to be able to provide professional development to schools that don't have PD budgets, but we haven't been able to completely fill the divide. There's still a huge amount of unmet need for STEM PD… Our state needs more funding for STEM professional development, so schools that don't have budgets can access that funding."

Funding
In 2016, MMSA reported total revenue of $2.06 million, expenses of $2.26 million, and net assets of $1.07 million.

Project Login
Project Login is an initiative of Educate Maine, a business-led nonprofit organization that champions college and career readiness and strives to increase the educational attainment of the Maine workforce. Project Login, founded in 2013, provides resources and creates partnerships to address the Maine's computing and information technology (IT) workforce shortage. It maintains an IT job board, provides computer science learning resources for K-12 students and educators, promotes IT training and higher education, and develops non-traditional pathways to computing and IT careers.

Project Login Director Jason Judd says, "We work with a number of the STEM education groups on defining how computer science fits into the broader world of STEM." He adds, "teacher professional development is a big issue for computer science education. More teachers need training in how to teach computer science, then we need to write computer science standards just like the other content areas, and DOE needs a point person like the other content areas. Computer science should be integrated into the preservice teacher training—across all teaching subjects. But the most inexpensive model is to train a teacher who is already teaching another subject to teach computer science."

Judd says that in Maine teacher professional development, "computer science is gaining traction because of code.org and Exploring Computer Science. I don't see a lot of high-quality math professional development, and I hear that a lot from math teachers, that they wish there were better continuing education offerings. There's such an emphasis on getting more students to achieve math proficiency, and Maine teachers need more help addressing that."

Project Login is an organizing partner in a new statewide partnership, **CS4Maine**. Computer Science for Maine (CS4Maine) believes that all Maine students, including those who have traditionally been underrepresented, should have access to computer science education. To accomplish its goal that computer science is a subject area offered to all Maine K-12 students, it advocates that Maine:
• Fund computer science professional development for teachers

- Offer computer science in all Maine high schools by 2022. All high students should have the opportunity to take at least one year of computer science.
- Offer computer science learning opportunities in all grade levels by 2025
- Allow computer science courses to count toward high school graduation requirements across the state
- Determine and implement appropriate K-12 computer science standards

Jason Judd says of CS4Maine, "We're going to focus on schools and communities without computer science education, and with high concentrations of racial/ethnic minorities or high proportions of low-income students. We'll work with cohorts of teachers to implement computer science. We're going to work with whole districts to have K-12 computer science pathways."

> *"There's a lot of resistance to computer science in the teaching profession. Even many math teachers don't know any coding, they aren't familiar with coding languages or the tools you would use to teach it. This comes back to the UMaine System. For pre-service teachers, and for recertification and continuing studies, some understanding of STEM needs to be built into the curriculum for all teachers. And Maine needs a real STEM certification in computer science teaching. There needs to be a payoff for the teachers in terms of pay structure."*
> Kim Quinn Hutchinson, Waterville Cyber Panthers

Maine Center for Research in STEM Education at the University of Maine (RISE Center)
The RISE Center is an interdisciplinary research center with the mission of improving both the study and the practice of STEM education in Maine, primarily in PreK-12 and also in higher education. Center Director Susan McKay says of the Center, "we are focused on identifying systemic problems, gathering evidence, working with teachers to figure out what assessments are meaningful, and figuring out how we can work with teachers to bring best practices to Maine faculty. We also prepare secondary teachers of science and math." The RISE Center houses a Master of Science in Teaching program and convenes the Maine STEM Partnership.

Members of the RISE Center include faculty, staff, and graduate students engaged in education research across STEM departments and the College of Education at the University of Maine. The RISE Center provides education and professional development for emerging educators through undergraduate and graduate opportunities, including teaching and research assistantships, a Master of Science in Teaching degree with a teacher certification option, and an interdisciplinary STEM Education PhD program.

Recent grant-funded professional development projects at the RISE Center include:
- A grant to convene middle school and first year of high school physical science teachers to study and share best instructional practices and materials. The project was evaluated, and researchers found that teacher practices changed, and their students benefited.
- A "STEM+C" grant to study the integration of science and computer science instruction. "Our grant will integrate computational thinking and coding options into science instruction through a team of teacher leaders who will design ways to integrate these computer science applications into subjects they are already teaching in middle

schools. Our research questions are: If you take some time out of traditional science instruction and teach computing, how does that affect learning? Can we help teachers feel confident about teaching computer science? Will students learn both?"

- A grant to study new STEM teachers in rural districts, examining resources they need to stay and thrive in those jobs.
- The development of coordinated, regional high school teacher collaborations in seven different parts of Maine. "We have seven people working together to lead the co-planning of professional development for each of those teacher groups and refine it. We should support more coordinated efforts like that, and not have so many separate, unconnected initiatives," says Susan McKay.

The RISE Center convenes the Maine STEM Partnership, "a STEM education improvement community" with the mission of building and sustaining a diverse, statewide community that strengthens PK-16 STEM education by promoting rich, research-supported classroom experiences that deepen learning and engage all students. The Partnership encourages students to become STEM educators and education researchers. Partnership professional development offerings include 3-D printing resources, high school teacher collaboratives, a cross-grade-level and -content-area teaching & learning community, a teacher-leader community focused on student-led learning, and several teacher affinity groups.

> *"Professional learning communities for teachers once they're out in the profession has really been lacking, and not just in Maine. Some other countries have amazing lesson study and co-planning practices, and that's shown to really help. I'd love to see us doing more of that...I think getting teachers more opportunities to work together and work with higher education faculty is so important. I'm not talking about running more one-day workshops. It needs to be ongoing and give people a chance to dig deeper in their practice."*
> Susan McKay, RISE Center

Key Informant Interview Summary

We interviewed seven experts on STEM education in Maine from six different organizations: Ed Cervone, Executive Director, Educate Maine; Jason Judd, Program Director, Project Login; Ruth Kermish-Allen, Executive Director, Maine Mathematics and Science Alliance; Seth Laliberte, high school math instructor, Rangeley Lakes Regional School; Susan McKay, Director, University of Maine Center for Research in STEM Education (RISE); Kim Quinn-Hutchinson, Executive Director, Computer Science Pilot in Waterville; and Shari Templeton, Science and Technology Content Specialist, Maine Department of Education.

Key themes that emerged from the interviews include:
- The quality of STEM education varies widely among Maine school districts. Some well-funded districts, a charter school, and a magnet school have exemplary programs, but many districts are not offering comprehensive, high-quality STEM instruction.
- Computer science: Across the K-12 system, 30% of Maine school districts offer computer science courses, and only 20% of middle schools offer them. There have been

some partnerships and teacher training through code.org and a group called Exploring Computer Science, but we need much more expansion.

- Math: Several informants feel that mathematics instruction in Maine needs significant improvement. "Frankly, math instruction in Maine is way behind. It's scary the percentage of students not meeting basic proficiency standards in math," says Susan McKay. Ruth Kermish-Allen agrees, "The way we're teaching math isn't working. We need a more experiential approach. A more integrated approach to subject matter. A project-based orientation serves the interest of kids."
- Science: Experts agree that Maine is on the cusp of adopting Next Generation Science Standards, a positive development that will require more professional development and collaboration to implement effectively.
- Engineering: Few interviewees discussed engineering instruction or enrichment, but Kim Quinn Hutchinson suggested that MSSM should develop a distance learning engineering program for middle schools.
- The importance of connecting STEM education to careers in Maine was echoed by several experts. Shari Templeton suggested, "It would be great experience to essentially load teachers up on a bus and take them on a business tour to see STEM careers at work. Have teachers be the student at work sites. See what's out there and available, give teachers a better perspective on where career opportunities are and will be for their students."

Key Insights from the Interviews

Today's STEM Education in Maine

Interest in STEM education has been growing, and Maine has several initiatives and groups working on it. But proponents say the policy and funding infrastructure at the state level is in adequate. Ed Cervone explained, "We've seen the state back away from its leadership role in education partnerships and investments. So, providing high-quality STEM education has stalled or failed to engage right at a time when it's become more and more critical to economic viability." Jason Judd says, "I think there has to be more state investment in high quality professional development in STEM for our current teachers. We have some private providers working in the state, but a lot of that is dependent on soft money, grants…the could make a big difference."

Shari Templeton, at the Maine Department of Education, signaled some awareness of the needs. "In terms of policy, it may be that we need to look at a more well-rounded balance in graduation credit requirements. Graduates have to take four years of English credits, and maybe we need to look at more than two years of science… We need to be looking to more computer science and engineering—that we are making sure those opportunities exist in every district in Maine… We need policy and funding to support the MLTI (Maine Learning Technology Initiative) program, which is sunsetting. And more investment in the technology infrastructure to support high quality STEM instruction in every district," she said.

Nearly all informants shared observations about the wide variance in the availability and quality of STEM education in different Maine regions and communities. "Maine has pockets

delivering high quality STEM education. But there are swaths that meet the bare bones, but don't do a lot to inspire students about learning STEM," says Shari Templeton.

"Our state has not used its education resources wisely, maybe because there isn't enough to go around. It's sprinkled too little in too many places to have the kinds of impact we all want to see," concludes Susan McKay.

<u>Best Practices in STEM Education</u>
Features of high-quality STEM education described by experts include:
- Hands-on laboratory activities, research, and experiments
- Group work
- Mentoring from professionals working in the field
- Connections to higher education
- Connections to STEM applications and careers in the local community
- Hands-on STEM learning away from home (school trips, summer camps)

Ruth Kermish-Allen says of high-quality STEM education programs, "What they have in common is the opportunity for students to design their own questions, what is the issue that they want to use problem-solving to address, then connecting them with educators, mentors, and community members who have the resources, knowledge and tools to help with designing the investigation and finding answers." Similarly, Shari Templeton says exceptional STEM education programs "blur the boundaries between the disciplines, provide access to resources and experts, give ample opportunity for students to pose questions and pursue those inquiries, and provide an avenue for students to be creative."

Susan McKay says, "the best models are a balance of exciting experiential learning in the classroom, with real strong intentionality about helping students develop the skills of basic science and the interest in scientific inquiry and scientific phenomena. Some more traditional learning experiences can balance well with project-based learning. Many schools are doing good community engagement, community research projects, giving students the chance to see STEM's relevance in their own communities." And she adds that high-quality STEM instruction fosters "the social side of learning. A lot of people have downplayed that in STEM, but it's so important. That's how people have success with the productive struggle of learning. Communicating your ideas, listening to other people's ideas."

<u>Equity in STEM</u>
Seth Laliberte's experience as a teacher in Rangeley's K-12 consolidated school sheds light on the regional equity issues between southern Maine and more rural and remote parts of the state: "It seems that there are a lot of smaller Maine schools in the same boat. I think the amount of curriculum and test prep we have to do, the pressure to prepare students for the SAT, has cut down on the time within the school day and the budget for faculty to teach things like computer science."

Underrepresented student groups in STEM majors and STEM careers include economically disadvantaged people and girls/women. "We need to continue to address the gender gap. Girls have lower STEM interest than boys. But more girls are successful in higher

education. So, the boy problem is continuing to higher ed and persisting, and the girl problem is interest in STEM fields," says Jason Judd.

"MSSM needs to be at the very center of STEM education in Maine. They need to be seen as the school that is doing STEM the best. They are not involved in those conversations enough. I think their mission should be really focused on how to raise the level of STEM education instruction, and they should focus on equity issues—regions of Maine, gender, and low-income student access. So, they could partner with certain counties, develop programs to help free- and reduced lunch eligible kids, focus on helping those schools and teachers. Find a way that MSSM could step in if there's no course or no teacher available in a middle school or high school STEM subject. A kid could virtually join a course or could go to MSSM to take that course…MSSM should be seen by schools a resource rather than as a competitor," suggests Jason Judd.

Shari Templeton described how equity issues relate to professional development and workforce demand: "The biggest need we have is student access to STEM programs. That ties to a huge demand for qualified teachers in STEM. We've got a shrinking teacher force, and people with STEM training are in high demand. They're in high demand for private sector jobs with high salaries, not just in schools, so you've gotta really have someone who's passionate about education to forego other opportunities in STEM to work as a classroom teacher. You can train educators working in other disciplines to teach STEM subjects, but then we have a shortage of professional development, again especially in rural and remote areas."

Future Directions
At the state level, Shari Templeton expressed optimism about STEM education in the near future. "The Governor has already started a Department of Innovation; I think that dovetails beautifully with the push for STEM. We have new science standards coming out—the Next Generation Science Standards. That will help make a science instruction better and higher-order learning more prevalent."

Ed Cervone believes that "what Maine needs most is some clear goals and plans, a vision for what we want to do and how we're going to achieve it. We need a building of capacity and expertise within the department of education, and a reinvestment in that. We have good STEM groups around the state and they do collaborate, but I don't know if they have the necessary resources or stature to leverage the scale of change and improvement that we need."

Other experts shared a range of future directions Maine should pursue:
- "Even at a small school, if we wanted to do more STEM—which I envision as having the math teacher and science teachers work together a lot and team teach—time is the biggest barrier. You need time to plan that kind of work, and we're already strapped for planning time. We have 182 school days, and 175 of those are days with kids. So outside of teaching, there's no time to get together and plan, come up with lesson plans and programs together. Especially to get deeper into problems or interdisciplinary questions…I think Maine needs a longer school year, for teachers especially. A 195- to 200-day school year for teachers would make a big difference. Teachers would be more

energized, they could have more professional development days both in summer and at different points throughout the year." –Seth Laliberte

- Laliberte's experience highlights the promise of "flipped classroom" teaching approaches: "By flipping the lessons, each student can get the instruction that's right for them, and their needs are being met. They won't listen to me do a math lecture. They can navigate the technology so well that this way of teaching works much better for them than a traditional lecture classroom. But they do need guidance, so I spend all my class time working through problems with them, in small groups or individually. All students do during class time in my classes is work on problems. I do targeted instruction and help. They watch the instruction videos for homework."

- Finally, Laliberte says, "I would like to see STEM collaborations between math and science teachers become more of a reality. I feel very isolated from how to make that happen. We need more training on how to collaborate, how to break down the walls between math and science classrooms."

- "We need to make sure that a range of high-quality STEM courses are available at all schools in Maine. Things like getting rid of "textbook page-turning" instruction and replacing it with activities, lab experiments, and problem-solving activities. Access to that is inequitable in Maine now… I think middle school is a perfect place to expand. Schools like MSSM are well positioned, from a faculty and an experience perspective, to help with this. We need to scale it up, and it would be a great opportunity to expand STEM education. Kids need to be producing instead of just consuming technology," says Jason Judd.

- Kim Quinn Hutchinson says of teacher professional development, "This comes back to the UMaine System. For pre-service teachers, and for recertification and continuing studies, some understanding of STEM needs to be built into the curriculum for all teachers. And Maine needs a real STEM certification in computer science teaching. There needs to be a payoff for the teachers in terms of pay structure."

- Judd adds, "Computer Science Principles should be offered in every Maine high school. Then, for students who want to go further, use higher education faculty to teach exciting advanced courses. These could be offered over distance during the school day, with face-to-face meetings over breaks and vacations. Partner college faculty with specific high schools. Many kids are going to want to pursue it further. And college faculty can make it engaging and exciting by teaching their passions. Some have fascinations with artificial intelligence or virtual reality—topics that are awesome for high school kids to explore."

- "I would love to see, first and foremost, a series of professional development workshops on integrating high quality STEM education into the classroom—across all subjects. Better access to professional development and instructional materials for teachers working in ALL Maine schools. A larger gathering across the state to better understand what STEM is, and how it exists in all of our communities," says Ruth Kermish-Allen

- Susan McKay offers, "Maine should have an integrated, aligned plan for STEM, digging deep into disciplines, but also strong interdisciplinary problem-solving opportunities. Students getting out and working in communities to understand the way STEM can be used to solve problems, how to work with evidence. It would be exciting to see Maine classrooms balancing creative, authentic research experiences with deep discipline learning and appreciation. I want every student in Maine to think STEM subjects are the

most exciting ones in the world, and for every student to feel as if they have the background to be ready to go into a STEM career."

- Kim Quinn Hutchinson says, "We need to build a strong partnership between STEM education organizations in Maine and economic development efforts. Get the state departments involved, get industry on board, bring together good models, and expand them."

Advice for MSSM

The key informants generously provided a range of valuable advice for MSSM.

Jason Judd said:
- "If MSSM was to start with one content area and focus on one level of students, that would be a good strategy. Probably middle school, then you're helping prepare students to go to MSSM. Offering professional development and distance learning courses would be a more comprehensive middle school approach than just the summer camp."
- "I would emphasize the importance of partnerships. Work with industry groups, other schools, nonprofits, training and education technology providers, advise them and seek their advice, split up the work. Partnerships are how work gets done in Maine."
- "I'd like to see MSSM dream a little bigger—beyond the resources they have right now. Think a bit more loftily. Hopefully these interviews will reveal some good opportunities."

Ruth Kermish-Allen offered:
- "I think that there is sometimes a feeling of shying away from partnering with MSSM faculty—maybe a bit of feeling intimidated? It would help to come at it with an attitude of being open to sharing different forms of pedagogy. Make it clear that you want to understand what it looks like and how it works in more traditional middle schools and high schools. I think we need to understand MSSM better AND they need to understand other Maine schools better."
- "Start that conversation. Who wants to collaborate? What kinds of facilities can MSSM offer? What kind of staff and capacity do they have? We would love to have them at the table when we plan collaborations."
- "Plug into the STEM Collaborative, and the STEM Council if it continues. Be present in those conversations, to understand who your most productive potential partners are, and how what they already are doing fits in with your strengths. I would love to be part of those conversations."
- "And don't lose sight of how important what you are offering now is. For kids who are not served in the local school, the opportunity to be around other kids and teachers that share their passion is powerful. That cohort model to get like-minded kids together—a safe place to get appropriate training and mentoring.

Seth Laliberte said:
- "I can see MSSM offering online courses to advanced students who are enrolled at public schools around the state—expanding their course offerings to similar students that they serve now but offering them through other public schools. If a school like MSSM offered calculus, statistics, or computer science online, I would definitely consider recommending that for our top students."

- "I honestly think they should target students who are motivated by STEM, especially in smaller schools. They should continue that. The job of the public schools now is to bring the bottom up—we focus where the most students are. And that means top students—a student who is unusually advanced at math, say—ends up on their own with a computer. It would be great to have MSSM courses as a resource for students all over Maine who don't have the curriculum they need at their home school."
- "Another unmet need MSSM could address is STEM professional development. Could they bring in math and science teachers from around the state to their campus to observe and see how they do STEM instruction, planning, and teacher collaboration? And maybe develop some workshops that they could offer in different parts of the state on those topics."

Susan McKay's advice is:
- "I would love to see MSSM become a leader for evidence-based improvements. The teachers there are scientists who know how to look for and share evidence of what's working."
- "Maybe they could collaborate on developing course curricula, or project-based learning experiences. One of the persistent problems that our community has identified is engaging students in STEM. Getting students to take ownership and think about issues and keep working on inquiries. Even and the university level, we find that students aren't always taking ownership, taking what they learn and moving forward with it. Maybe that is less of a problem at MSSM, but they could share strategies and ways to tackle that with other schools."
- "Go as participants [in professional learning communities]. Having them join in these educator professional communities would be a real asset."
- "There are challenges around gender balance in STEM education. I did notice that your faculty in some typically tricky areas are male—all the physical science and computing teachers are male. I would work to bring in strong women role models in all the fields. If you want to provide strong education for girls and boys, you need that balance."
- "I think using MSSM almost like a lab school to better understand teaching and learning in STEM, how to best teach students, particularly rural students, would be helpful to the state. We as a research center could certainly partner with MSSM in that area."

Kim Quinn Hutchinson suggested that MSSM develop a distance learning engineering program for middle school:
- "Because we know math and science—at least the basic levels—are well covered in Maine schools, I would start with great courses in engineering first—there is NOTHING in that area in Maine schools now. And I would start with middle school."
- "If I were at MSSM, I would create blended STEM courses for middle school students first, focusing on engineering... Local teachers could serve as mentors for students enrolled in MSSM online courses, and supplement MSSM teacher instruction. As you move forward, I think we could be your partner for the computer science piece. Why have everybody reinvent the wheel? We could work together to make a jointly-offered series of online computer science courses, for middle school and then for high school."

Shari Templeton suggested:

- "If MSSM were to start offering STEM professional development, there certainly is room for that. Summer offerings, like one- or two-week intensives in different subjects would be a great addition. Summer Institutes for teachers and students at MSSM would be a great opportunity."
- "It would be great if they branched out into serving more students in more places in Maine. It makes more sense not to go below grade four, probably. But there is so much room for more, better STEM classes and experiences for our middle and high schoolers. And it would be great if MSSM was all-inclusive, serving students of all abilities and interests, although that can be tricky when you're looking at higher-order thinking skills."

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Maine Mathematics and Science Alliance
- Website: https://mmsa.org/our-work/current-projects/

Maine Virtual Academy
- Website: https://meva.k12.com/our-curriculum/high-school-curriculum.html

- Monitoring Report: www.maine.gov/doe/sites/maine.gov.doe/files/inline-files/MeVA%20Annual%20Monitoring%20Report%202018.pdf

Project Login
- Resources for educators: www.projectlogin.com/education/educators
- Code.org resources on teaching computer science: https://studio.code.org/courses?view=teacher

Robotics organizations
- MaineFIRST Robotics League: www.mainefirst.org/
- Maine Robotics: www.mainerobotics.org/

Teacher associations
- Association of Teachers of Mathematics in Maine, https://atomim.wildapricot.org/
- Maine Computer Science Teachers Association, https://www.mainecsta.org/
- Maine Science Teachers Association, https://msta.wildapricot.org/

Thornton Academy STEM Pathways
- School website: www.thorntonacademy.org/page.cfm?p=615
- Program of Studies: https://view.joomag.com/program-of-studies-program-of-studies-2018-19/0082367001518720626
- *Portland Press Herald* article, August 2018: www.pressherald.com/2013/08/21/umaine-thornton-academy-start-innovative-engineering-program

University of Maine Academ-e:
- Website: https://umaine.edu/earlycollege/academ-e/

University of Maine at Fort Kent Rural U
- Website: https://communityed.umfk.edu/about/rural_u/
- Portland Press Herald article: www.pressherald.com/2018/11/05/umaine-early-college-program-seeks-to-fill-gaps-in-maines-workforce/

Waterville Cyber Panthers computer science program
- Center for Curriculum Redesign: https://curriculumredesign.org/ccr-announces-computer-science-pilot-at-waterville-me-high-school-thanks-to-grant-from-the-harold-alfond-foundation
- School website: www.watervillecyberpanthers.com/