Higher Education and Secondary Schools Coming Together: Strengthening STEM Education Through Collaboration

Maine STEM Landscape Analysis: Higher Education

MAINE EPSCoR

Campus Compact Maine

STEM

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Maine STEM Landscape Analysis: Higher Education

Executive Summary

In 2014, Maine Campus Compact (MCC), with support from Maine Experimental Program to Stimulate Competitive Research (EPSCoR), conducted a statewide landscape analysis to assess ways to advance science, technology, engineering and math (STEM) education and collaborative opportunities between higher education, K-12 schools and community partners in Maine. Seventy school districts and 20 higher education institutions throughout the state received one of two surveys: one for secondary schools (SS) and the other for higher education (HE) institutions. In total, surveys were sent to 573 secondary school (SS) and higher education (HE) educators, administrators and staff (see Appendix Tables 1 and 2) with a 29% average response rate. In this report, we detail the findings of the HE report including current STEM education practices and challenges in STEM education. Informed by these findings, this report also introduces a comprehensive model emphasizing initiatives, known as *STEM Engaging Initiatives,* to address identified gaps in Maine STEM education.

Central findings from the HE survey revealed:

- HE respondents consider the top three challenges facing STEM HE & SS education to be: lack of preparation for college level STEM courses, insufficient funding, and inadequate links between the K-20 pipeline.
- 91% of HE respondents believe that collaborations between higher education and K-12 schools would help strengthen STEM education.
- Most effective HE STEM initiatives identified to strengthen SS STEM education were: college student-led STEM activities, professional development for SS teachers by faculty, and access to HE research sites for SS students.
- Most effective faculty incentives identified to encourage increased collaboration with SS were: stipends, help identifying collaborative opportunities, and assistance with SS outreach.
- Only 59% of HE respondents report that they currently integrate community engagement into STEM curricula, despite 93% of secondary school (SS) respondents stating that doing so would strengthen STEM.

Introduction: The Need to Increase STEM Collaboration in Maine

By 2018, nationwide job openings for careers in technology and engineering are expected to increase by 50% in comparison to non-STEM jobs.[1] In Maine, one-in-seven new jobs will be STEM related.[2] Despite these trends, in 2010, Maine ranked second lowest in New England in the number of STEM bachelor degrees granted [3] while in 2014, Maine ranked 44th nationally in college graduates employed in STEM occupations.[4]

An added consideration is that recent research has linked students' academic trajectory in STEM fields with family background, reporting that socio-economic status significantly influences a SS student's participation and achievement in STEM course work.[5,6] Secondary school students from middle- and high socio-economic status backgrounds receive higher levels of encouragement, exposure, and access to STEM experiences that may foster greater interest, confidence, and academic skills in STEM necessary to achieve a postsecondary degree.[7] On the opposite end of the spectrum, these results pose a difficult challenge for students in Maine, where in 2015, nearly half of all Maine students (47.6%) qualified for free and/or reduced meals in school.[8] These statistics suggest that Maine students need increased knowledge and skills in STEM to become academically competitive, to engage as citizens, to find meaningful professional work, and to build and sustain vibrant communities.

What, then, can be done to set more Maine students on a path to pursue STEM education and careers? Dr. Jay Labov, a Senior Advisor for Education and Communication for the National Academy of Sciences and former faculty member in the Biology Department at Colby College, advocates for developing STEM as an *educational ecosystem*, in which each classroom, student, institution, administrator and teacher has a role to play, depending on and influencing one another.[9] Other STEM researchers and policymakers funded by the Noyce Foundation explain:

> "A STEM learning ecosystem encompasses… a variety of environments that together constitute a rich array of learning opportunities for young people. A learning ecosystem harnesses the unique contributions of all these different settings in symbiosis to deliver STEM learning for all children. Designed pathways enable young people to become engaged, knowledgeable and skilled in the STEM disciplines as they progress through childhood into adolescence and early adulthood."[10]

Affirming the need for more collaboration, the Maine Department of Education's (DOE) Strategic Plan for STEM (2010) states, "the Department recognizes that collaboration with governmental, non-governmental and higher education partners is essential to strengthening STEM education for Maine students."[11]

Recognizing the underutilized resource of higher education, in 2014, Maine Campus Compact launched a new STEM initiative aimed at strengthening the link between higher education and K-12 schools as well as empowering K-20 STEM collaborative opportunities. MCC, a coalition of 18 Maine campuses engaged in reinvigorating the public purpose and civic mission of higher education, is uniquely positioned to work with higher education to take a more collaborative role to address what the DOE has stated as critical for strengthening STEM education in Maine.

In 2014, with support from AmeriCorps VISTA and the Maine Experimental Program to Stimulate Competitive Research (EPSCoR) at the University of Maine, MCC conducted two statewide surveys (one for SS educators and one for HE faculty), and a series of related focus groups. These surveys inquired about the current landscape and potential opportunities for strengthening the STEM pipeline through collaborative efforts. The results of the surveys have offered new, helpful insights. Additionally, they have confirmed some expectations about the challenges and gaps in the current STEM educational environment. Perhaps most importantly, although the results reported an inadequate link between higher education and secondary schools through the state, they have also provide the beginnings of a road map for addressing these gaps.

The aim of this report* is to showcase important findings from the HE survey about current STEM challenges and opportunities for collaborative partnerships between HE and SS institutions that could strengthen STEM education in Maine. Informed by these findings, MCC aims to mobilize higher education to take a more active role in initiating and/or participating in STEM initiatives to bridge identified gaps with Maine K-20 STEM education.

Study Sample

The HE survey sample consisted of faculty and administrators from 20 HE institutions throughout Maine. The survey was sent to faculty from MCC's member campuses and three additional institutions chosen for their impact and location (see Appendix Table 1). Of the total 223 higher education faculty and administrators who received the survey, 30% responded. Sixty percent (60%) of those who responded were STEM faculty while the remaining respondents were higher education administrators (10%), staff (12%), or teacher education faculty (18%). Of the respondents who instructed STEM subject matter, many taught one or more courses in the sciences (57%), technology (27%), engineering (18%), and math (18%).

Study Findings

The findings from the HE survey afforded new insights from HE perspectives about the current state of STEM programming in Maine, including specific challenges and opportunities. The findings have also provided a foundation for effective collaborative initiatives to help address STEM educational gaps.

Challenges to STEM Education in Maine

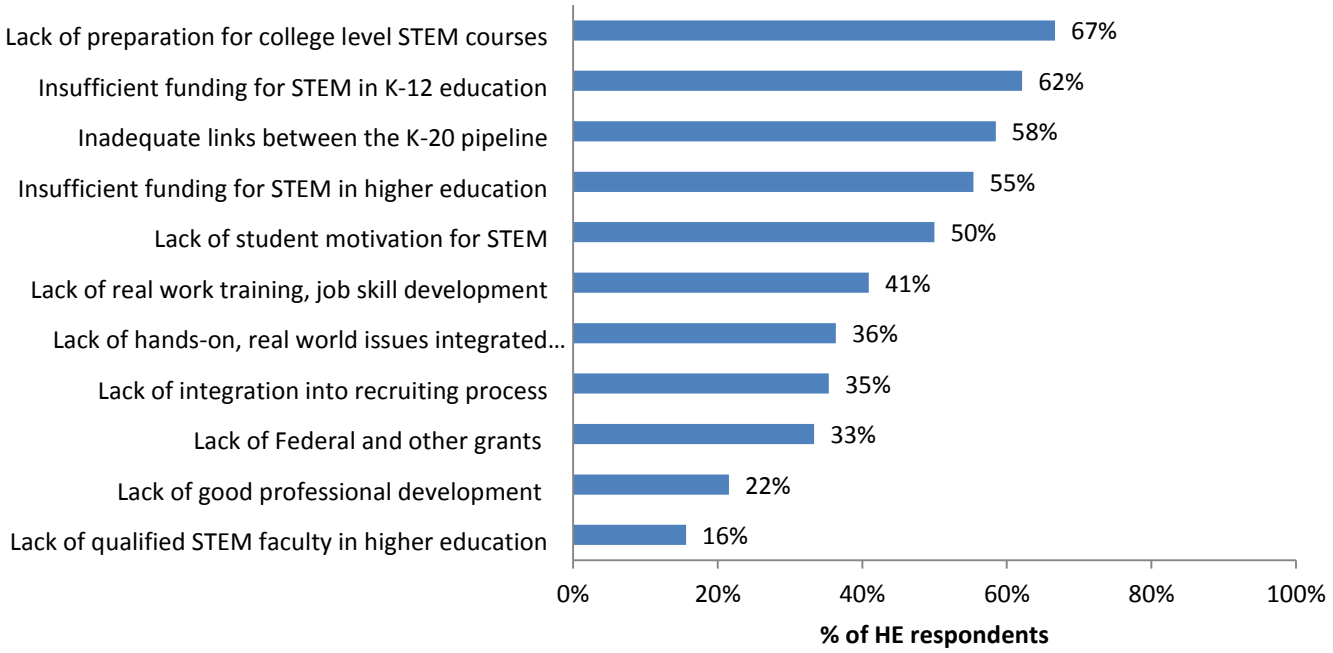
Maine students will be entering a highly competitive global workforce that demands a skill set including critical thinking, problem solving, communication, and teamwork. Schools at all levels are employing strategies to engage students in real-life educational experiences, allowing them to hone these critical skills while mastering essential academic content. To be competitive in

* MCC has a comparable SS report and Executive Summary available.

this increasingly interdependent world, students will require increased knowledge and skills in STEM fields. Despite this, Maine students show a decrease in skill level from middle school through high school.[12] These challenges within the STEM pipeline have brought about concerns and renewed efforts to improve the quality and effectiveness of STEM education in Maine.

HE respondents reported that the top challenges facing HE STEM in Maine are: (1) lack of student preparation for college level STEM courses; (2) insufficient funding for STEM in both K-12 and higher education; and (3) inadequate links within the K-20 pipeline (Figure 1). Identifying these challenges from the perspective of HE faculty allows for a better understanding of how to improve and strengthen these programs.

Figure 1. Major challenges facing STEM higher education in Maine as identified by HE respondents



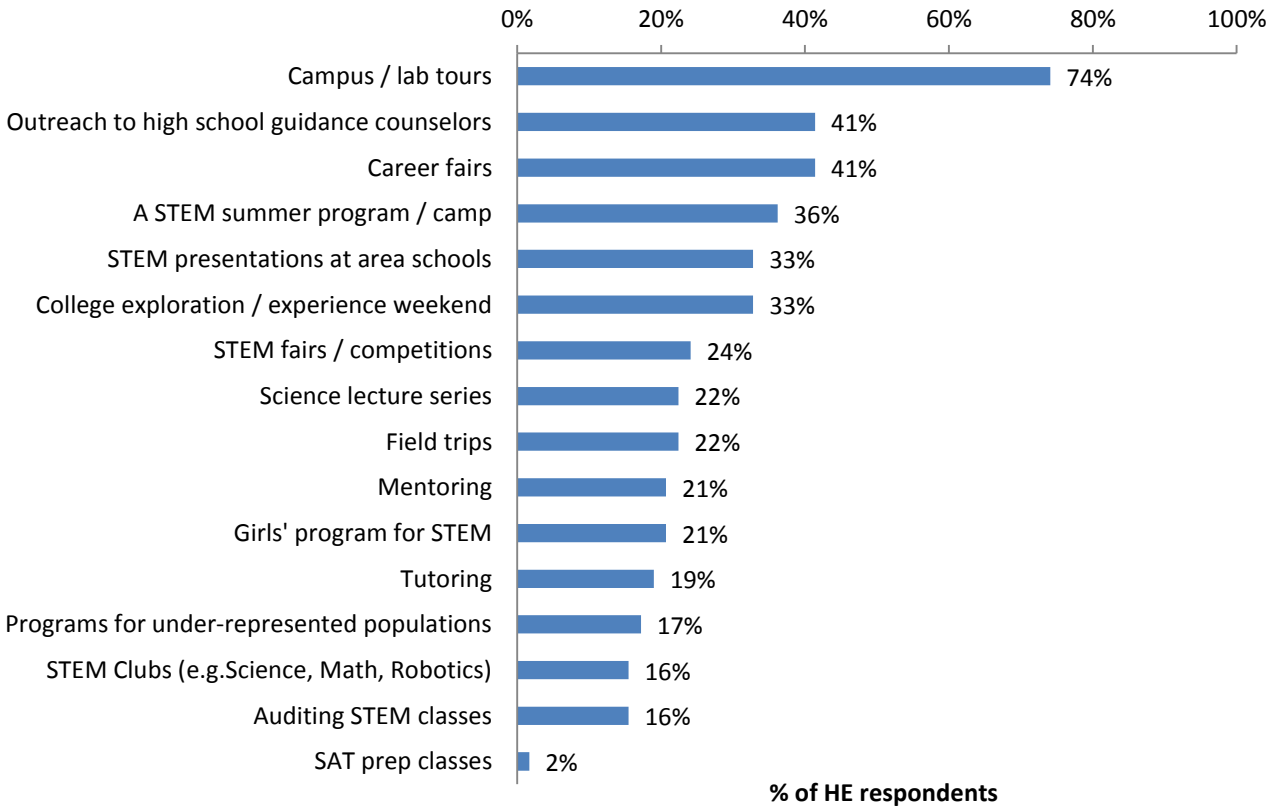
In open-ended responses, HE respondents also referenced a culture of STEM fields being perceived as difficult and encouraged to only those students with a "natural aptitude" for STEM. Some respondents also noted that student motivation for STEM seems to drop off in middle school, and that there exists a gender bias toward boys in STEM subjects.

SS respondents answered similarly about the major challenges facing STEM SS education. According to SS respondents, significant challenges to strengthening the STEM pipeline include: lack of funding (90%), lack of professional development for STEM educators (83%), and inadequate links between the K-20 pipeline (78%). These data demonstrate the need for stronger links between higher education and K-12 schools to strengthen STEM education.

Current STEM Practices at Higher Education Institutions Linked to Secondary Schools in Maine

HE respondents reported current STEM practices at their college/university that have been implemented to connect and strengthen STEM programming for K-12 schools. Respondents overwhelmingly (74%) identified providing campus or laboratory "tours" to secondary school students as the primary way HE institutions interact with SS schools (Figure 2). The next most cited offerings were outreach to guidance counselors (41%) and career fairs (41%).

Figure 2. Current HE STEM initiatives offered to secondary schools in Maine

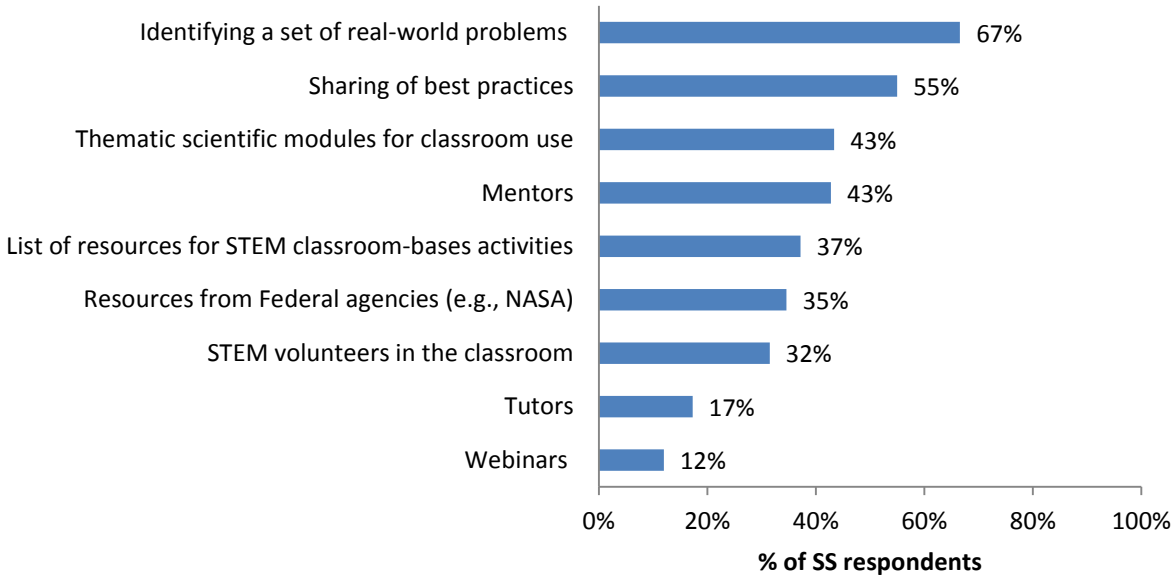


These findings suggest that the most utilized STEM practices currently provided by higher education for secondary schools may be lacking a more hands-on approach that could have a more significant impact on K-12 students. Additionally, the open-ended question of what SS teachers find to be *most* effective for engaging students in STEM (Figure 3) elicited strong support for hands-on work (95%) and real world activities (81%). SS respondents felt active learning is critical because it helps students apply what they learn in science and math to their own experiences in their homes and communities.

Effective Opportunities for Strengthening STEM Education in Maine's K-12 School Districts

When SS respondents were asked to choose from a list of strategies that would be most effective in supporting their STEM needs, the top three responses were: identifying real world problems, sharing of best practices and thematic scientific modules for classroom use (Figure 3).

Figure 3. Resources identified by SS respondents to strengthen STEM education



SS comments concerning best approaches included:

> *"I want my students to invest their best efforts, for that to happen the students must see the real world connections between what we do in class and what goes on out in the community and beyond." (Technology Education Teacher, Brunswick High School)*

> *"The most effective way for me to engage students in STEM work is to have it applicable to their lives." (Science Teacher, Gardiner Area High School)*

Despite the SS findings, results from the HE survey showed that *less than 25%* of HE institutions are currently providing experiential programs like field trips, interactive STEM fairs, and mentoring/tutoring programs (Figure 2) to expose SS students' interest in STEM. To better address the needs identified by SS educators (Figure 3), hands-on activities and real-world problem solving should play a central role in HE outreach to secondary schools. Feedback from a SS focus group noted, for example, that making HE campus/lab tours more interactive and immersive for SS students, versus having them observe a lab, goes a long way toward providing a more effective and integrated experience for SS students.

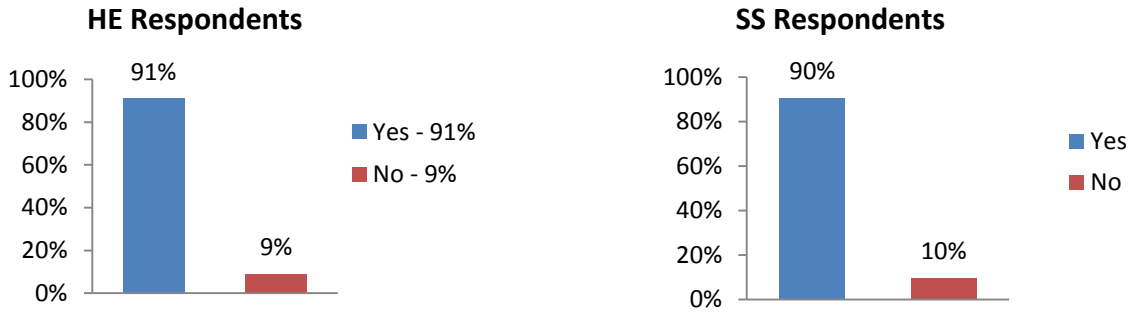
Paving the Path to STEM in College: Dual Enrollment

When strategizing about how best to collaborate with secondary schools, one hopeful area of interest is dual enrollment in which high school students can earn college credit for taking STEM-related coursework. Although only 25% of HE institutions surveyed currently offer STEM AP or online courses for high school students, data from the survey highlighted the growth of dual enrollment programs. Fifty-six percent (56%) of respondents cited that their HE institution currently offers dual enrollment programs for high school students. At institutions where dual enrollment is not currently offered, HE respondents reported a 67% likelihood of their institutions integrating dual enrollment programs in the next three years.

Collaborative Opportunities for HE Faculty and SS Educators to Strengthen STEM in Maine

Data from our surveys show that HE and SS respondents both overwhelmingly believe that increased collaborative opportunities between HE and SS would help address STEM needs in Maine (Figure 4).

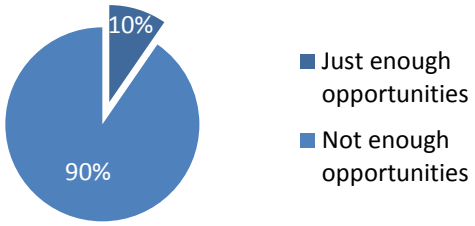
Figure 4. Percentage of HE and SS respondents that believe stronger connections between higher education and secondary schools would bridge gaps in STEM education



K-12 and Higher Education Collaborations

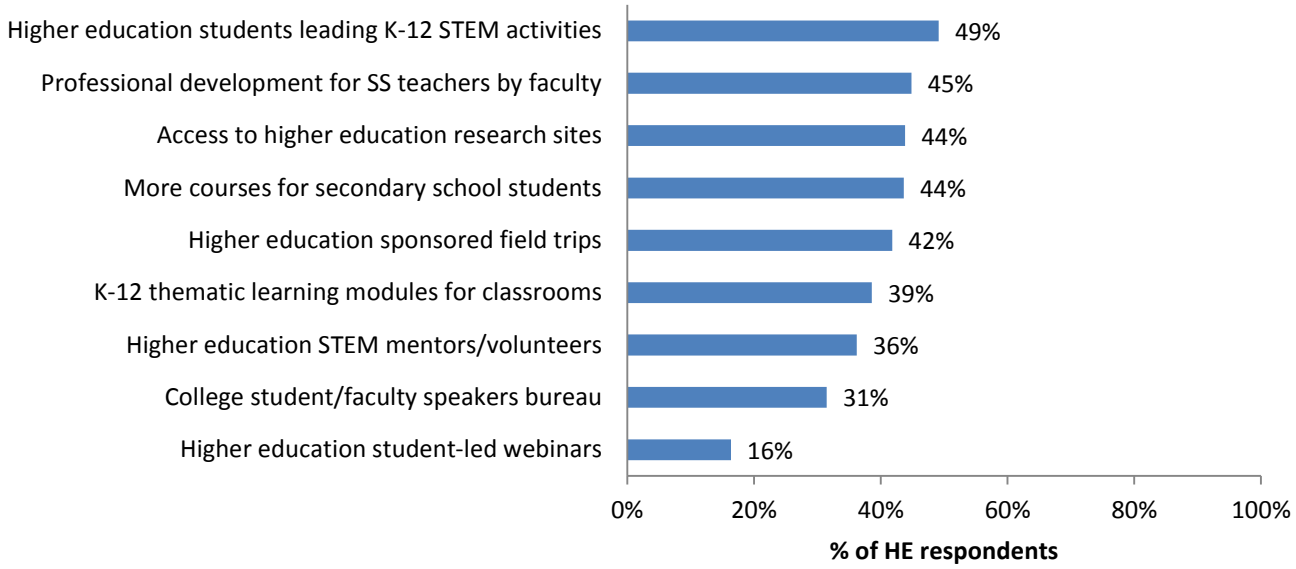
Although there is strong support for more connections, ninety percent (90%) of SS respondents believe that there are currently *not enough* STEM collaborative opportunities between secondary schools and higher education (Figure 5). In fact, only 29% of HE respondents identified current best practice collaborations with secondary schools to help strengthen the STEM pipeline. HE respondents did, however, identify STEM initiatives they believe would be the most effective in strengthening the STEM pipeline in the future (Figure 6). College students leading STEM activities (49%) topped the list of proposed effective initiatives. Professional development for SS teachers by

Figure 5. Percentage of SS respondents that believe there are not enough collaborative opportunities between SS and HE institutions



HE faculty (45%), access to research sites for SS education (44%), and more course opportunities for high school students (44%) were the next three most common responses.

Figure 6. Most effective HE initiatives identified for strengthening SS STEM needs



Of the SS respondents requesting stronger connections between secondary schools and higher education institutions, fifty-five percent (55%) identified field trips to HE research sites as the most effective type of collaboration, followed by professional development opportunities (52%), one-week learning modules around specific topics for classroom use (52%), and college student-led STEM activities (44%) (Table 1). As noted on page 6 of this report, the more interactive these activities are for SS students, the more effective and long-lasting the educational impact.

Table 1. Most effective types of collaborations with HE Institution(s) to address SS STEM needs

Collaboration	SS Response
Field trips to higher education learning labs/research sites	**55%**
Professional development opportunities	**52%**
One-week learning modules around specific topics for classroom use	**52%**
College student-led STEM activities	**44%**
Mentoring for students	**37%**
College student/faculty speakers bureau	**28%**
More AP or dual enrollment opportunities for students	**28%**
Tutors for students	**21%**

Both SS and HE respondents stated that collaborations between higher education and secondary schools would not only help expose students to STEM fields, but would also

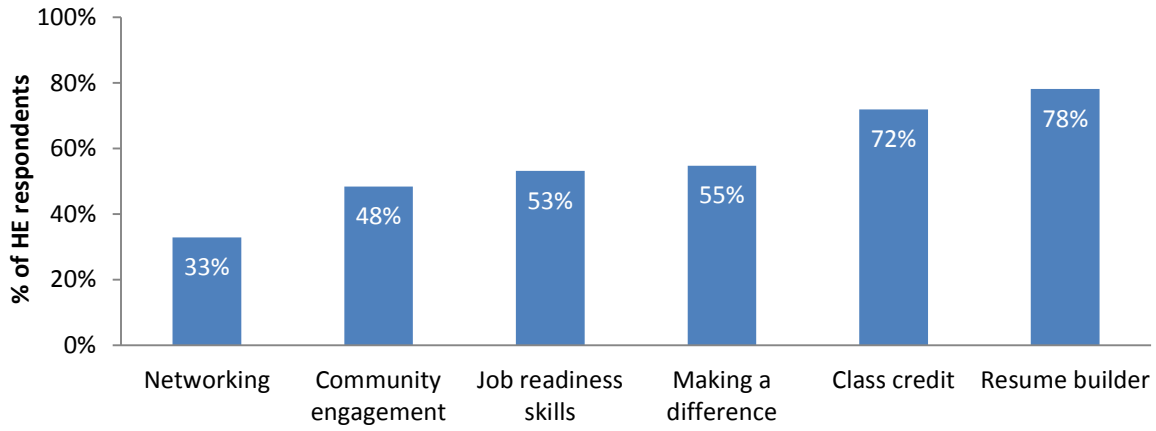
reinvigorate SS educators to strengthen STEM programs at their schools. The survey findings reinforce the need to eliminate communication barriers between K-12 schools and post-secondary education while building new relationships and collaborative opportunities within the STEM pipeline.

Other Potential Benefits/ Opportunities to Strengthen STEM

Benefits of Collaboration for HE Students and Career Awareness

From the HE survey, greater than 90% of HE respondents believed college students would benefit from participating in collaborative STEM opportunities with local secondary schools. Key benefits include: increased communication skills (50%), leadership skill development (39%), and real world experience/application (39%). The survey also asked HE respondents to identify student motivations for participation in these collaborations (Figure 7). Additionally, the survey highlighted the importance of increasing awareness about viable career options available to graduates with a STEM degree. Despite the growth in STEM fields, only 15% of HE respondents, to an open-ended question, referenced promoting STEM careers to their students.

Figure 7. College student motivation for participation in collaborative STEM opportunities with secondary schools



Undeclared Majors: Potential for Recruitment

According to the 2012 Age Details Report within the University of Maine System (UMS), 6.5% of students age 18 to 19 had undeclared majors, while 5.9% considered themselves undecided in their major.[13] With nearly 13% of incoming and undeclared UMS students unsure of their educational focus, there is an opportunity for higher education to do more to introduce these students to STEM majors.

The results of this study have also helped to shed light on the level of HE efforts to attract these students to STEM majors. Only 18% of HE respondents reported a very strong commitment to attracting undeclared undergraduates into STEM majors at their college or university. Forty-seven percent (47%) were only partially committed. To steer students toward the STEM fields, institutions currently offer lectures and presentations (44%) and outreach (44%) to attract undecided and undeclared students. Other approaches include career service presentations

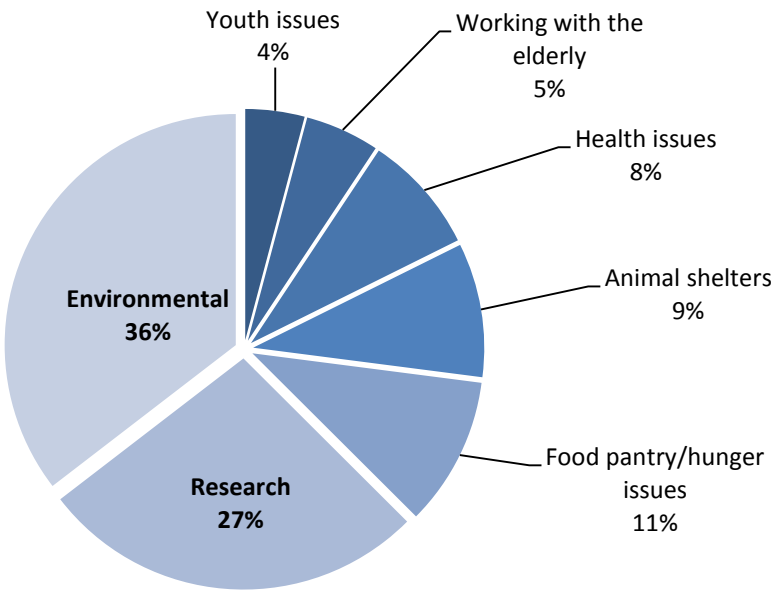
(34%), internships (28%), and mentoring programs (23%). Despite these efforts, 59% of respondents believe these approaches to be ineffective. In some cases, STEM faculty members are solely responsible for recruiting students. In an open-ended question, some HE respondents suggested that more hands-on and interactive STEM activities integrated into coursework and more exposure to STEM related career options might help attract more undeclared students into STEM fields.

Integrating Service-Learning and Community Engagement into School Curricula

While STEM professional development is widely recognized as important to student success, educators also increasingly understand the importance of preparing civic-minded students. According to the American Association of Colleges & Universities, higher education has shifted toward providing students with skills that serve them during their lifetime. As stated by Hurtado and DeAngelo (2013), higher education needs to *"prepare students for the society we aspire to become, practices that empower them to create a world that is more equitable, just, democratic and sustainable. Therefore, we should not only develop critical thinking skills among our students, but also equip them as citizens with the drive, values, capacity to question, and ability to develop solutions in order to advance social progress."*[14]

Service-learning is an educational approach that connects community service with formal education. Through service-learning curricula, students learn practical, problem solving skills to remedy real world problems that benefit communities. Among HE respondents, the most frequent issue areas of service learning integration into STEM curriculum include environmental issues (36%), research (27%), and food pantries (11%) (Figure 8).

Figure 8. Current issue areas of service-learning integrated into HE STEM curricula in Maine

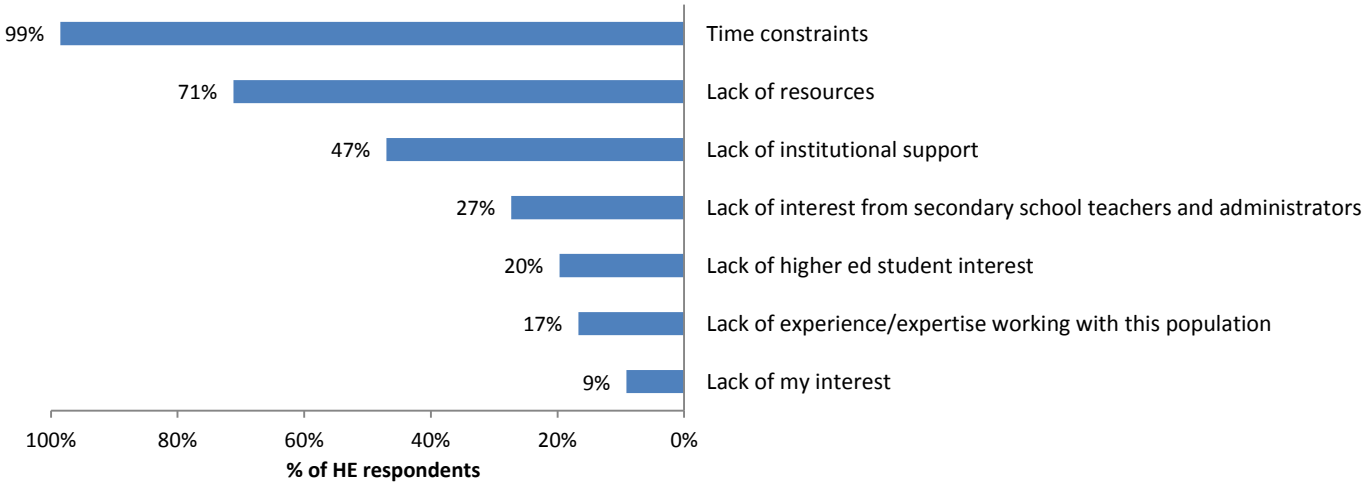


Despite an increase in awareness about the important links between community engagement and global issues, HE institutions from our landscape analysis indicate only a moderate level of service learning integration into STEM curriculum. With only 59% of HE respondents reporting that they currently integrates community engagement into STEM curriculum, an opportunity exists for greater levels of participation, especially given that 93% of SS respondents believe community engaged learning (including hands-on, real world experiences) would strengthen STEM education. To better strengthen the STEM K-20 pipeline and increase real-world problem solving skills in students, it may be beneficial for higher education to consider greater integration of more service learning into STEM curricula, thereby closing the 34% gap between what is currently offered and what SS would like to see occur.

Institutional and HE Faculty Commitment to Collaboration and Alignment

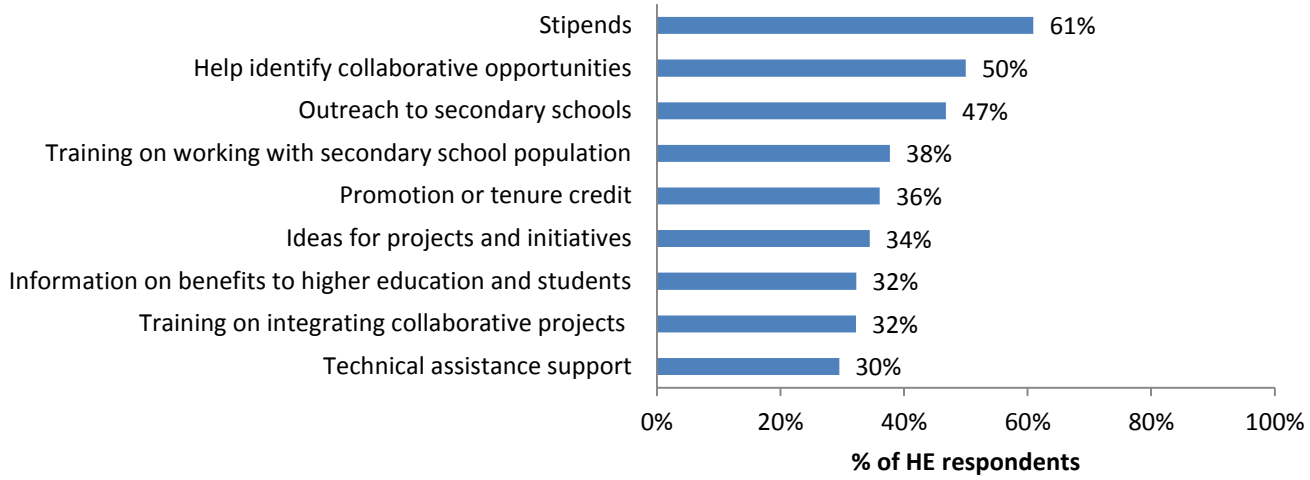
The results of the survey showed HE institutions were either "very" or "somewhat" committed (87% combined) to STEM education, according to HE respondents. HE respondents also reported that their institutions were either "very" or "somewhat" committed (79% combined) to implementing new, innovative approaches to enhance STEM learning. Recognizing the value of K-20 collaborations for strengthening STEM, over 98% of HE respondents said "yes" (51.6%) or "maybe" (46.8%) that they would be willing to help implement collaborations. Only 1.6% responded "no" to this question. When asked about possible barriers to participation, ninety-nine percent (99%) of HE respondents cited time constraints as the greatest barrier to their participation with collaborative opportunities. Lack of resources (71%) and lack of institutional support (47%) were also considered barriers to faculty participation (Figure 9).

Figure 9. Barriers to faculty participation with STEM collaboration initiatives



Given these data, it is clear that greater support and incentives for faculty participation (i.e. course release time) are important to the success of collaborations between secondary schools and HE institutions. In addition to faculty stipends (61%), HE respondents stated that help identifying collaborative opportunities (50%) and assistance with outreach to secondary schools (47%) could help increase their commitment to participate in new STEM initiatives that strengthen the K-20 pipeline (Figure 10).

Figure 10. Faculty Incentives to implement collaboration with secondary schools

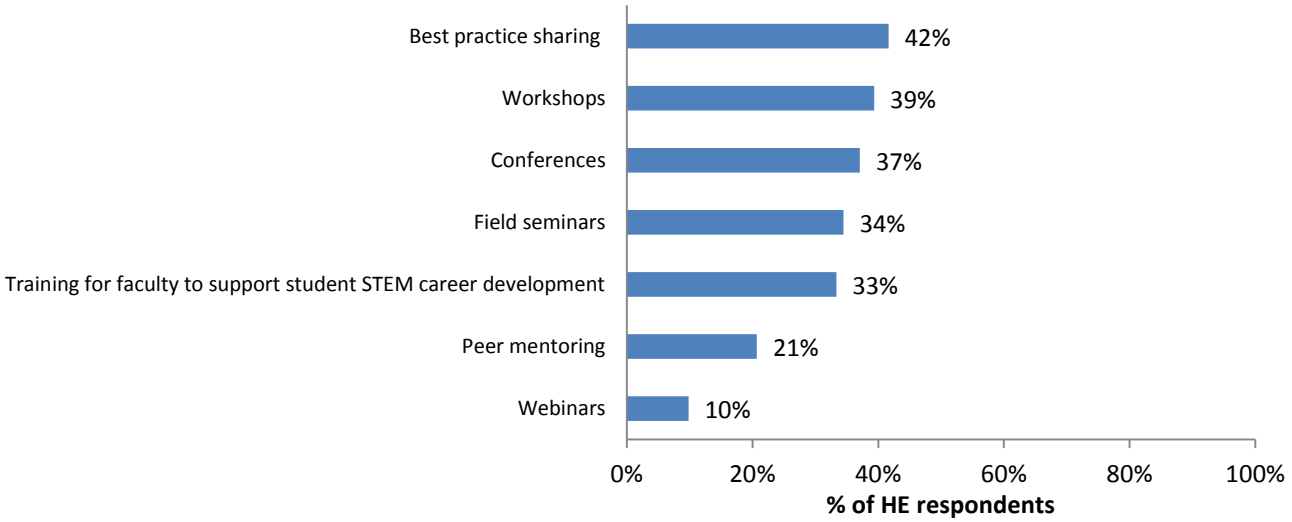


As detailed in the *Broader Impacts* section at the conclusion of this report, MCC is well positioned to assist HE member campuses with identifying more collaborative opportunities, providing training, and facilitating outreach assistance with secondary schools. Utilizing our HE network and knowledge of service-learning, we aim to generate greater support and incentives for faculty and SS teachers to participate in STEM collaborations within the educational ecosystem.

Professional Development for Faculty

To adequately address opportunities for HE educators to participate in SS collaborations, it is important that faculty have access to cutting edge service-learning training and techniques. According to 69% of HE respondents, efforts to keep faculty current in their respective fields and to regularly provide them with STEM professional development opportunities are insufficient. Respondents cited best practice sharing (42%) and workshops (39%) as the most effective professional development practices (Figure 11).

Figure 11. Effective professional development strategies for addressing STEM needs for HE faculty



This data illustrates a clear need for an increase in professional development opportunities. An example of effective professional development strategy that integrates critical issues and community engaged learning into STEM curriculum is Science Education for New Civic Engagement and Responsibilities (SENCER). Funded in part by the National Science Foundation, SENCER incorporates civic engagement into teaching curricula, and has proven to be an accessible, easily shared, and replicable model for teaching at all levels.[15] Despite professional development, collaboration with higher education, and more hands-on approaches being identified as high-need by SS respondents, only 6% knew of SENCER, and only 8% of those who were aware of it integrated SENCER's models into their teaching.

Best Practices, Alignment and Hands-On Collaboration: Open-Ended Responses

When asked about best practice collaborations with secondary schools for strengthening STEM, twenty-nine percent (29%) of HE respondents provided useful suggestions including collaborative research projects between HE faculty and SS students, dual enrollment, and career days. Additional best practices cited by HE respondents included increasing the availability of university tours, offering summer field courses for college credit, and inviting SS students to experience college courses for a day.

A common challenge cited by HE and SS respondents was a misalignment of both higher education and secondary school curricula with reference to student retention in the STEM fields. Both HE and SS respondents believe STEM curricula for both K-12 and HE institutions need more cohesive curricular alignment with one another. To fill this educational gap, HE respondents also felt there was a need for more frequent collaboration to prepare STEM K-12 teachers. Hands-on, practical applications of scientific concepts were acknowledged as key to successful STEM education. HE respondents stressed that more support is needed for SS curriculum development to include hands-on, inquiry-based instruction. HE respondents also recommended training college students in service-learning and having them help with K-12 classroom projects as well as after-school programs.

SS respondents provided a number of recommendations about how higher education can help strengthen STEM in K-12 schools and overcome some these identified challenges. These recommendations included:

- Clarity about STEM college standards so students are prepared for such courses
- Be more inviting to STEM K-12 teachers
- Offer better STEM teacher training
- Develop links to university and lab researchers

The overall perspective from both SS and HE respondents was that STEM curricula within the K-20 STEM pipeline needs to be more cohesive and better aligned to prepare students along their academic trajectory.

Key HE Survey Conclusions

Key challenges facing HE institutions related to effective STEM programming are: (1) **lack of preparation for college level STEM courses**, (2) **insufficient funding for STEM in K-12 education,** and (3) **inadequate links within the K-20 pipeline.**

91% of HE and 90% of SS respondents believe that **collaborations between higher education and K-12 schools** would help strengthen STEM education.

STEM practices between K-12 schools and HE exist but **need to be expanded and enhanced** and **more hands-on** with their approach in order to have a **lasting effect on SS students**. SS respondents identified that professional development opportunities, field trips (interactive) and one-week learning modules around specific STEM topics would prove most effective.

More than 90% of HE respondents believe **college students will benefit from participating in collaborate STEM projects with SS**. Key benefits include: increased communication skills, leadership skill development and real-world application.

Key barriers to faculty participation with STEM collaborations include time constraints (99%) and lack of resources (71%). **Faculty incentives for overcoming these barriers** include stipends and assistance with outreach, collaboration, and identifying partners for collaboration.

Almost 70% of HE respondents stated there are **insufficient STEM professional development opportunities for HE faculty**. Best practice sharing and attending workshops/conferences were identified as the most effective professional development strategies for higher education.

Broader Impacts: STEM Engaging Initiatives

Feedback from MCC's statewide landscape surveys (SS and HE) show overwhelming support, and many opportunities for greater collaborative efforts and community engagement between K-12 and higher education for strengthening STEM programming. The results of the SS and HE surveys have provided a valuable road map for helping to address gaps in STEM education, and have culminated in the development of a menu of achievable, easily replicated, collaborative models, referred to as *STEM Engaging Initiatives*.

To help make these initiatives readily available, in 2016, MCC will offer technical assistance support to K-12 schools and postsecondary institutions interested in identifying and implementing collaborations focused on the following six *STEM Engaging Initiatives*:

- ✓ *Community Conversation Starters* – To help initiate new STEM collaboration efforts in communities, MCC will organize and facilitate meetings with representatives from local higher education institutions and K-12 schools. The goal of each meeting will be to conduct introductions, share current best practices, and identify/initiate potential collaborative STEM opportunities.

- ✓ *Field Seminars* – Technical assistance support will be provided for developing hands-on, field-based experiences for college faculty and students to partner with K-12 classrooms to implement research activities that also promote civic engagement. Seminars will also provide professional development for educators at all levels.

- ✓ *Interactive Speakers Bureau* – Students and faculty from higher education institutions, business and industry leaders, as well as STEM role models will be identified for the Interactive Speakers Bureau. The speakers will visit school districts to run interactive, hands-on STEM activities with a special emphasis on rural schools/districts.

- ✓ *Interactive STEM Fairs* – Teams of college students will be on site at schools/districts to lead interactive STEM-related stations for K-12 students. College students will receive training prior to working with elementary and secondary school students.

- ✓ *SENCER Trainings for Educators and Faculty* – Professional development training sessions will be offered on SENCER (Science Education for New Civic Engagements and Responsibilities) techniques. SENCER courses and programs are hands-on and connect STEM content to critical local, national, and global challenges.

- ✓ *Thematic STEM Modules* – STEM module toolkits will be a resource available to educators, formal or informal, working with K-12 youth. These toolkits provide the STEM content needed to successfully complete experiential, science-based activities focused on central, real-world themes.

Through the implementation of these collaborative, hands-on *STEM Engaging Initiatives,* a sample of anticipated benefits to be yielded include:

- ❖ Elementary and middle school students become more enthusiastic about STEM subject matter, while high school students become more cognizant of post-secondary STEM education, training and research opportunities that address vital community issues.

- ❖ Undergraduate and graduate students learn useful teaching techniques and develop leadership and other 21st century skills through HE student led initiatives for K-12 classrooms.

- ❖ SS educators have greater access to professional development opportunities and improved STEM curriculum development among a constantly changing landscape.

- ❖ HE faculty members enhance community outreach skills and increase communication and collaborations with their K-12 counterparts resulting in greater alignment of STEM education and student learning outcomes.

- ❖ Community needs are addressed through the integration of civic engagement into STEM curricular and co-curricular activities.

Evolving from STEM Pipeline to STEM Ecosystem

When referencing STEM education, the term 'STEM pipeline' is used to describe the trajectory of preparing K-20 students in STEM subjects from an early age to graduation and beyond. Metaphorically speaking, this unidirectional pipeline seems to address the focus necessary for students to begin and complete academic programs in STEM. However, after reviewing many of the findings from the survey reports and combined with Jay Labov's comments, it is apparent that this traditional and unidirectional approach to STEM education may be limiting the parameters of student learning. Educators and administrators report the need for a paradigm shift in STEM education toward a new, non-linear model necessary to guide the next generation of scientists and problem solvers. By moving towards a multi-dimensional, inclusive educational ecosystem, MCC aims to encourage greater depth and a wider reach for higher education and community collaboration and partnership.

Higher education has an instrumental role to play in the move towards a vibrant, interactive STEM ecosystem and is well-positioned to do so. Through the resources of MCC's higher education network, our expertise with service-learning, and implementation of the *STEM Engaging Initiatives*, MCC aims to support Maine STEM education's transition from a unidirectional pipeline, or traditional model, into a vibrant, interconnected ecosystem. Most importantly, this inclusive model removes isolating barriers between pre- and post-secondary schools and encourages new relationships and collaborative opportunities throughout the STEM ecosystem. This approach is a win-win for everyone: schools, K-20 students, K-12 educators, higher education faculty, and communities.

Conclusion: Our Vision for Maine's STEM Ecosystem

Envision…

HE faculty and SS teachers working reciprocally to lead the next generation of scientists and problem solvers while addressing critical issues.

> *HE student-led initiatives serving as important resources for SS schools that have the duel-benefit of providing college students with a "hands-on professional laboratory" to test out new teaching techniques under the guidance of faculty members.*
>
> > *Educators at all levels better connected with one another, having more opportunities for collaborative professional development, and unified by the common goal of encouraging students to explore their interests in STEM while addressing real world problems.*
> >
> > > *Increased student exposure to hands-on STEM education that helps develop 21st century skills.*

This vision is possible through added campus/K-12 school community partnerships as highlighted in this report and through greater STEM educational alignment, collaboration and resource sharing. To ensure that the United States retains its position as one of the most educated populations in the world, K-12 schools and community organizations need to enhance their utilization of post-secondary school education effectively to foster the next generation of STEM professionals.

It is MCC's hope that the STEM survey findings in this report and the subsequent *STEM Engaging Initiatives* will be effective tools for increasing multi-dimensional collaborations within Maine's educational ecosystem to strengthen STEM education. By encouraging new relationships, MCC aims to connect educators through collaborative opportunities and prepare students to become effective problem-solvers and citizens for building and sustaining vibrant, healthy communities as the next generation of scientists and STEM professionals.

Appendix Table 1. Maine colleges and universities that received the HE Survey

- Bates College
- Bowdoin College
- Central Maine Community College
- Colby College
- Eastern Maine Community College
- Kaplan University
- Maine College of Art
- Maine Maritime Academy
- Northern Maine Community College
- Saint Joseph's College
- Southern Maine Community College
- Unity College
- University of Maine at Augusta
- University of Maine at Farmington
- University of Maine at Fort Kent
- University of Maine at Machias
- University of Maine at Presque Isle
- University of Maine
- University of New England
- University of Southern Maine – Portland

Appendix Table 2. Geographic areas in Maine housing secondary and middle schools that received the SS Survey

Towns

- Auburn
- Augusta
- Bangor
- Biddeford
- Bonnie Eagle
- Bradley
- Brewer
- Brookville
- Brunswick
- Cape Elizabeth
- Castine
- Easton
- Eddington
- Fairfield
- Falmouth
- Farmington
- Fort Kent
- Freeport
- Frenchville
- Gorham
- Hallowell
- Lewiston
- Lisbon
- Lyman
- Machias
- Manchester
- Minot
- Oakland
- Orono
- Portland
- Presque Isle
- Sabattus
- Saco
- Scarborough
- Sebago Lake
- Shawmut
- South Windham
- Thorndike
- Topsham
- Troy
- Waterville
- Westbrook
- Winslow

Consolidated Towns

- Cape Cottage
- Cape Rosier
- Danville
- East Limington
- East Machias
- Eggemoggin
- Fairbanks
- Farmington Falls
- Fort Kent Mills
- Freedom
- Harborside
- Jacksonville
- Kennebec
- Maple Grove
- Mapleton
- Marshfield
- Mechanic Falls
- Penobscot
- Poland
- Pond Cove
- Sprague ville
- Standish
- Steep Falls
- Stillwater
- Temple
- Unity
- Whitneyville

Technology Centers

- Biddeford Regional Center of Technology
- Capital Area Technical Center
- Foster Regional Applied Technical Center
- St. John Valley Technology Center
- Lewiston Regional Technical Center
- Mid-Maine Technical Center
- Portland Arts & Technology Center
- Presque Isle Regional Career and Technology Center
- Somerset Career and Technical Center
- St. Croix Regional Technical Center
- Tri-County Technical Center
- Westbrook Regional Vocational Center

Charter Schools

- Baxter Academy for Technology & Science
- Harpswell Coastal Academy
- Maine Academy of Natural Sciences

STEM Schools

- Yarmouth High School STEM School
- Maine School of Science and Mathematics

Endnotes

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About Maine Campus Compact

Founded in 1994, Maine Campus Compact is a coalition of 18 member campuses whose purpose is to catalyze and lead a movement to reinvigorate the public purpose and civic mission of higher education. We seek to transform our campuses in ways that develop better informed, active citizen problem-solvers, stronger communities, and a more just democratic society. We believe that our campuses must be vital agents and architects of a flourishing democracy.

About Maine EPSCoR

Experimental Program to Stimulate Competitive Research (EPSCoR) was initiated at the National Science Foundation (NSF) in 1978 and now encompasses EPSCoR programs at several other Federal agencies. Maine EPSCoR at the University of Maine oversees and implements the state's NSF programs. Since 1980, Maine has received more than $62M in NSF EPSCoR funding. These statewide programs advance Maine's research capacity and competitiveness for a sustainable future through cutting edge science, STEM education, workforce development, cyber infrastructure, and economic development.

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