Governor's Task Force Report on K-12 Science, Technology, Engineering and Math Education

First Annual Report

Released September 2016 to

Her Excellency Margaret Wood Hassan,

Governor, State of New Hampshire

Governor's Task Force Report on K-12 Science, Technology, Engineering and Math Education

Implementing Pathways to STEM Excellence:

Inspiring Students, Empowering Teachers and Raising Standards.

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Overview

In April 2014, Governor Maggie Hassan issued an Executive Order creating the state's first K-12 Task Force on Science, Technology, Engineering, and Math (STEM) Education. The Task Force brought together a group of stakeholders representing education, business, policy makers, and K-12 NH parents with the goal of providing ideas and plans to modernize STEM education in NH schools and to help students prepare for the many STEM career opportunities in the state. The initial work of the Task Force resulted in eight core recommendations, which were presented in the final Task Force report to the governor in January 2015 entitled "Pathways to STEM Excellence: Inspiring Students, Empowering Teachers, and Raising Standards."

Governor Hassan re-established the Task Force through an executive order issued on July 15, 2015, in order to implement the recommendations from the final report. In her remarks, the governor declared that

> This diverse groups of leaders from education and business communities came together last year to propose a robust set of recommendations, and I look forward to their work to help implement those recommendations and to continue the ongoing process of strengthening public education in New Hampshire.

In the annual report to follow, the Task Force work implementing the recommendations from the 2015 report to the governor is reviewed. The recommendations are in the core areas of:

- Strengthening STEM Foundations with a focus on: (i) establishing STEM literacy standards that include coding, (ii) alternative math pathways that would broaden options beyond the current dependency on calculus for college-bound students, (iii) increased offerings in coding and computer science and including explicit incorporating of a course in coding as a mathematics credit-earning option in one pathway, and (iv) support for strong science standards with expanded applied learning opportunities in the curriculum.

- Inspiring Students
    - Founding a NH Math and Science Academy and alternative high schools and high school programs for students who wish to excel in STEM.
    - Modernizing Career & Technical Education to include more robust academic training and new job skills sets that will prepare students

for advanced manufacturing, biotech, information technology, healthcare technologies, and other careers utilizing extensive application of STEM.

- o Initiating personal learning plans beginning in middle school that will expose students to STEM (and other) career opportunities and will subsequently encourage exploration while building students' personal portfolios of experience and reflection.
- o Mentoring and involving girls in K-12 STEM activities and increasing the numbers of young women in STEM careers in NH.
- o Invigorating STEM interest among K-12 students (but especially middle schoolers) through the introduction of team-based competitions and projects that enable students to apply academic learning in interesting and exciting activities.

- <u>Empowering Teachers</u>
  - o Expanding options for STEM teacher training, including one credit and certificate-bearing and badge-awarding training for a broad range of STEM educators.
  - o Expanding regional professional development support hubs for teachers in order to promote strong communities of STEM educators that share curriculums, pedagogical approaches, and instructional resources.

Among the actions and achievements of note in this annual report are:
- recommendation to establish STEM literacy standards, that includes coding;
- development of four new math pathways for high school graduation, one that incorporates coding and computer science;
- introduction of a new pilot Teach Code Academy in partnership with the Massachusetts Institute of Technology and STEAM Ahead to train NH teachers to integrate coding across the curriculum;
- work with the Council of Chief State School Officers to review and recommend an overhaul of pre-service and in-service teaching credentials, including the appropriateness of a new category of STEM certificates and micro-credentials;
- preparation for a feasibility plan by the end of year for a establishing a NH Math and Science Academy;
- pilots for Personal Learning Plans for middle school students;

- initiation of the state's first STEM virtual hub for K-12 teachers, students, and parents.

Highest Priority Activities and Recommendations

While there are many areas of importance acted on and/or recommended by the Task Force, there are two priority areas[1] of highest importance which will lay the groundwork for future success of all STEM K-12 education programs. The Task Force recommends focusing efforts in the last three months of 2016 and first six months of 2017 on:

1) Establishing STEM literacy standards that include coding, and

2) Adopting Math Pathways.

<u>STEM Literacy Standards</u>

To ensure a strong 21-century education for New Hampshire students STEM literacy standards are required. State model STEM literacy standards should be added to language and math literacy standards in K-12 education. Adding STEM standards will enable New Hampshire K-12 graduates to effectively engage in a rapidly changing world that requires understanding of science, technology, engineering and mathematics and their intersections.

Enhanced STEM literacy will require providing STEM exposure and learning support early on in education, daily and in a variety of ways. This should include delivering STEM courses and content in various formats such as virtually and online and in combination with face-to-face studies and include exposing students to STEM labs and spaces to design and work on STEM projects. Schools should support students to follow their natural curiosity and to be creative as they pursue STEM research, applied projects and studies. Encouragement and mentorship will be important for all students but particularly for students in rural areas and for girls and other groups who have not been traditionally encouraged in STEM fields.

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[1] The priority areas that are reviewed here are then presented again in the main text of the report with other Task Force activity areas.

With rapidly changing technology and scientific advances it is important for STEM education and STEM education standards to encourage students to engage actively in learning STEM and to learn STEM at advanced levels. With many of the most important learning and STEM advancements taking place in applied activities or at the workplace, it is important for every student to have the opportunity of an applied STEM-inquiry type of experience or course. It could be an independent scientific project. It could be an open-ended science project or engineering design exercise. Or it could be a work experience. And, since increasing number of STEM or STEM-related fields require advanced knowledge, students should be encouraged to take STEM courses at advanced levels including at the college level. The latter could be at a college, or a dual enrollment course at a high school. Students that have STEM work-based experience along with college credit should earn an employability credential upon graduation, demonstrating their preparedness for STEM career and college success.

Integration of coding into STEM literacy. In addition to the ("named letter") STEM foundations, <u>coding,</u> taught either across the curriculum, embedded within a course in computer science, or as a distinct course should be included in the STEM literacy standards that are established. Code (or coding) is the language of the 21st century. To be successful in careers and life increasingly requires knowledge of computer coding. Coding as part of K-12 education is about teaching logic and broad concepts about how coding is the language that makes technology work, rather than learning a specific language. Coding should be introduced in pre-K and primary education with games and basic concept instruction. The math classroom can be a logical place to introduce coding concepts to students, but other classrooms including art, design and social science classrooms can and should also introduce coding and advance coding skills and knowledge. With increasing numbers of employers seeking graduates with computer literacy skills and with more and more life skills requiring knowledge of coding, it is imperative for all students – even those who do not go to college and those who go to college who want to major in the arts, humanities and social sciences – to learn coding.

Many of the graduates of NH's schools in the 21st century will aspire to be members of the next generation of scientists, inventors, technicians and developers of new theories in order to solve the many complex problems we face to make New Hampshire and the world a better place to live. All will be living in a world in which STEM literacy will be required to be successful and well-informed.

<u>Adopting Math Pathways</u>

New Hampshire should embrace the position taken by the National Council of Teachers of Mathematics and the Mathematical Association of America, which states that, although calculus is important, "...the ultimate goal of the K–12 mathematics curriculum should not be to get students into and through a course in calculus by twelfth grade but to have established the mathematical foundation that will enable students to pursue whatever course of study interests them when they get to college."[2] Although a calculus pathway is considered particularly beneficial to students who may wish to study engineering or physics at the college level, an advantage to offering multiple pathways is that students who are going on to college can choose a non-calculus pathway can still study engineering or explore studies related to careers in the health sciences, business, or the biological sciences and those not considering college can be on math pathway that can support their employment or life interests.

All pathways should include applications to move the discussion from abstract or general concepts to "applied" math. The examples should also include engineering in addition to the physical and biological sciences. The fourth pathway, introduced during the course of this year's Task Force work, was added explicitly to provide the solid grounding in the mathematical foundations required for entrance into the STEM-related certificate and degree programs offered at NH two- and four-year colleges and universities. Regardless of which pathway a student chooses, coding should be integrated into the math curriculum. Furthermore, the ability to interpret data, including visualization, should be emphasized in all four pathways.

[2] "Joint Position Statement of the Mathematical Association of America and the National Council of Teachers of Mathematics" on Calculus (March 2012). Retrieved from http://www.nctm.org/Standards-and-Positions/Position-Statements/Calculus/

The Task Force recommends the following four specific pathways:

Calculus	Data/Statistical	Linear Algebra	Engineering Technology/Industry
Algebra 1* Geometry Algebra 2 Pre-Calculus/ Trigonometry Calculus	Algebra 1 Geometry Algebra 2 Probability/Statistics	Algebra 1 Geometry Algebra 2 Linear Algebra	Pre-Algebra/Basic Mathematical Modeling Applied Algebra I Applied Geometry Applied Trigonometry (1 Semester) Coding with Mathematical Focus (1 Semester)
*Students may take Algebra I in eighth grade or two math courses during their sophomore-senior years, for example Geometry and Algebra II during the sophomore year.			

STEM K-12 Education Leadership and next steps

The Task Force has served to help to advance key STEM K-12 education in NH work since its inception. Continued cross-sector statewide leadership in STEM K-12 education is critical to maintain the momentum of progress that has been made.

Below are the **next steps** for the remainder of 2016 and first six-months of 2017:

- develop formal STEM literacy standards that include coding and have these adopted alongside language and math literacy standards;
- gain formal endorsement of alternative math pathways and acceptance of coding as a course meeting state mathematics graduation requirements; and

- continue progress on the other recommendations and activity areas of the STEM K-12 Education Task Force outlined in text below.

In the remainder of this report, numbered recommendations footnoted at the start of each section refer to the numbered recommendations from the January 2015 Task Force Report to the Governor.

Foundations in STEM

Recommendations:[3]   Develop Math and Coding: Pathways for STEM Success and Support Next Generation Science Standard

Background and Goals. The 2015 Task Force report noted that, in order to achieve the goal of increasing the number of New Hampshire residents pursuing NH-based STEM careers, and to increase the number of New Hampshire students studying STEM in college, a stronger and broader array of mathematics and science offerings is needed, particularly at the high school level. The Task Force therefore issued the following recommendations.

- Alternatives to the traditional calculus-only advanced mathematics pathway be developed at the high school level. Specifically, the Task Force recommended that pathways culminating in (i) statistical thinking and (ii) linear algebra be developed as additional choices for students.
- Coding be incorporated into all school systems, both through explicit coursework emphasizing computer science and its principles at the high school level and through the incorporation of coding across the curricula at the middle and high school levels, and, as appropriate, at the elementary school level.
- High school level courses in coding be developed that earn high school mathematics course credit.
- State science standards be reviewed and, as appropriate, revised in order to incorporate more explicitly hands-on, open-ended learning, with a goal of developing and adopting standards based on Next Generation Science Standards (NGSS).

Actions and Achievements. The Foundations in the STEM working group established goals in three specific areas.

- Alternative Math Pathways aimed at developing recommendations for specific high school mathematics courses that would constitute each of the three proposed pathways, one emphasizing calculus, one emphasizing data and statistical reasoning, and one emphasizing linear algebra. In the course of this effort, the working group added a fourth pathway that was created specifically for students who wish to pursue STEM careers that do not immediately require four-year college preparation.

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[3] These were recommendations #1 and 2 in the 2015 STEM Task Force Report

- With regard to coding, developing high-level guidance for the recommended content of a high school coding class suitable for mathematics credit. Such a course is intended to complement efforts that teach elements of coding as a component of other courses, including those in mathematics. As a corollary to this task, it will be useful to identify possible process(es) through which teachers may acquire the background or credentialing necessary to teach coding in high school and to develop a list of resources for teachers at the pre-school through eighth grade levels (P-8) who wish to incorporate coding into their existing curricula.
- Beginning the work necessary to enable NH to adopt Next Generation Science Standards (NGSS)- or science standards based on NGSS.

Responsibility for the development and adoption of revised statewide science standards was shifted to the NH Department of Education early in fiscal year 2015-2016. Although working group efforts were therefore focused on alternative math pathways and coding, the working group remains strongly supportive of developing NH science standards based on NGSS and incorporating hands-on, open-ended learning in order to encourage retention and understanding as well as to foster curiosity and creativity.

In developing Alternative Mathematics Pathways, the working group recommends adopting the position taken by the National Council of Teachers of Mathematics and the Mathematical Association of America, which states that, although calculus is important, "...the ultimate goal of the K–12 mathematics curriculum should not be to get students into and through a course in calculus by twelfth grade but to have established the mathematical foundation that will enable students to pursue whatever course of study interests them when they get to college."[4] Although a calculus pathway is considered particularly beneficial to students who may wish to study engineering or physics at the college level, an advantage to offering multiple pathways is that students who choose a non-calculus pathway can still study engineering or explore studies related to careers in the health sciences, business, or the biological sciences.

[4] "Joint Position Statement of the Mathematical Association of America and the National Council of Teachers of Mathematics" on Calculus (March 2012). Retrieved from http://www.nctm.org/Standards-and-Positions/Position-Statements/Calculus/

All pathways should include applications to move the discussion from abstract or general concepts to "applied" math. The examples should also include engineering in addition to the physical and biological sciences. The fourth pathway, introduced during the course of this year's Task Force work, was added explicitly to provide the solid grounding in the mathematical foundations required for entrance into the STEM-related certificate and degree programs offered at NH two- and four-year colleges and universities. Regardless of which pathway a student chooses, coding should be integrated into the math curriculum. Furthermore, the ability to interpret data, including visualization, should be emphasized in all four pathways.

The working group therefore recommends the following four specific pathways:

Calculus	Data/Statistical	Linear Algebra	Engineering Technology/Industry
Algebra 1*	Algebra 1	Algebra 1	Pre-Algebra/Basic Mathematical Modeling
Geometry	Geometry	Geometry	Applied Algebra I
Algebra 2	Algebra 2	Algebra 2	Applied Geometry
Pre-Calculus/ Trigonometry	Probability/Statistics	Linear Algebra	Applied Trigonometry (1 Semester)
Calculus			Coding with Mathematical Focus (1 Semester)
*Students may take Algebra I in eighth grade or two math courses during their sophomore-senior years, for example Geometry and Algebra II during the sophomore year.			

In developing a high-school level course on coding, the working group recommends that any such course enable students to learn some of the key ideas of computer science and to understand computational thinking. Broadly, the working group recommends that these courses consider adopting the approach of the MIT/Harvard curricular recommendations for high school coding classes and teach students (i)

computational concepts, often referred to as the "nouns and verbs" of coding, (ii) such practices as abstraction, iteration, testing, and reusing, and (ii) perspectives that express and connect ideas and that may include the development of basic algorithms, with the goal of helping students develop a framework for problem solving using computation. Coding will enable students to understand computational biology (how the genetic code works), algorithms (mathematical instructions that make up programs), computer intelligence, and recursion, in which solutions to small problems can be applied to larger ones.

A high-level syllabus that outlines the recommended topics for a high school coding class is included in Appendix A.

A Teach Code partnership was facilitated by the Task Force between MIT's Teacher Education Program (http://education.mit.edu/) and the STEAM Ahead program. This partnership resulted in the two-day Tech Code Academy held at the University of New Hampshire-Manchester (UNH-M) on June 14-15, in which over 40 teachers from Manchester West and McLaughlin Middle School and White Mountain Regional school district participated. The teachers worked with staff at the MIT Center to learn how to integrate coding across the curriculum in a coherent and appropriately sequenced method. This partnership will support the effective incorporation of coding across the curriculum in the targeted districts and will develop a pilot/model program for other NH school districts to adopt.

In the short term, not all high schools will have the resident expertise to teach a course on coding or the resources to develop such expertise. Therefore, in addition, the working group encourages the utilization of community colleges through expanded dual enrollment course sequences or of the Virtual Learning Academy Charter School (VLACS) partnerships when appropriate.[5]

Regarding credentialing for teaching high school coding or computer science courses, the working group recommends that the Professional Standards Board

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[5] Among current efforts, The STEM Discovery Lab at the University of New Hampshire/ Manchester provides professional development and extended learning opportunities in Computer Science and Coding such as The *Creative Computing Challenge*, an NSF-funded initiative that combines a student summer camp with a teacher professional development Institute, and includes school-year workshops and support for participating teachers. *NH CS4HS* (based on MIT App Inventor) is a Google-sponsored hybrid course to prepare teachers to teach AP Computer Science Principles. Contact the NH Department of Education for details on NHCS4HS. See Appendix F.

develop a subcommittee to study the educator qualifications needed for effective education in the area of computer science. If a new endorsement is recommended by the subcommittee, the Professional Standards Board should propose rulemaking to the NH State Board of Education in order to develop an educator credential in the area of computer science.[6]

In addition, the working group recommends that computer science and coding be included in in any new state guidelines for micro-credentialing.

The working group is also awaiting the completion of the work of the NH Department of Education as part of a consortium funded by the Council of Chief State School Officers regarding educational credentialing for both pre-service and in-service teachers. The expected completion date for this work is June 2

Next Steps. In conjunction with the Department of Education, this working group is reviewing action(s) necessary for the formal endorsement of Alternative Math Pathways and acceptance of "coding" as a course meeting state mathematics graduation requirements.

There is a need for further meeting(s) with NH Department of Education and State Board of Education to address approval of Alternative Math Pathways, which would become part of a statewide New Hampshire Pathways model for every high school program of study.

The MIT Teacher Education Program-STEAM Ahead coding initiative pilot should be evaluated and its expansion of the program to other school districts considered for the summer of 2017 and thereafter.

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[6] The Computer Science Teachers Association (CSTA), Core.org, the National Math and Science Initiative and others in the computing community are leading efforts to create a framework for K-12 computer science education (K12cs.org) that can be adapted by states and school districts. The New Hampshire Professional Standards Board has been following these efforts. A final report from K12cs is expected in September, 2016

Inspiring Students

Recommendation:[7]   Personal Learning Plans for Middle School Students

Background and Goals.   The 2015 Task Force report recommended introducing Personal Learning Plans (PLPs) at the middle school level that would enable young students to encounter holistic, cohesive, and real world STEM work experiences. These opportunities would frame a system of planning and preparation extending through post-secondary education.

In this implementation phase of the Task Force recommendations, Personal Learning Plans provide a framework in which career exposure, explorations and engagement can be captured. This implementation plan includes an advisory model through which students are guided by adults and older peers including teachers, administrators, parents, and mentors; the basic premise is that "it takes a village" to advise and support children on their journey to a satisfying career (See Appendix C).

The purpose of PLPs, as originally articulated in the Task Force report, is to bring greater coherence, focus, and purpose to the decisions that students make regarding their short- and long-term educational and career goals. PLPs are not intended to limit, or "pigeon hole" students, but to expose and engage them in STEM opportunities that align with their interests, skills, and talents. Based on these intentions, the implementation plan focuses on a number of specific goals.

Goals.

- To expose young people to STEM and other career and life opportunities, and allow them to explore these opportunities.
- To align interests and skills to career passions.
- To provide tools for students to capture, retain, and build upon their interests as they grow and change.
- To encourage successful transitions from middle school to high school to postsecondary education or career.
- To align coursework better with career interests.

The key to Personal Learning Plans is getting started in middle school (or earlier) and drawing on the strong forces already working in the schools. By starting early,

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[7] This was recommendations #5 in the 2015 STEM Task Force Report

middle school students are better prepared to choose STEM classes and opportunities in high school because they have already been exposed to stimulating and engaging career opportunities at pre-high school levels. To do this, students, parents, teachers, and business communities need to take joint ownership of personal learning plans and to understand that middle school is definitely not too early to be intentional about building STEM career awareness and ultimately pathways to those careers (and to college).[8] This effort could easily be integrated into the advisory models that many NH middle schools already have in place.

Actions and Achievements. In the first phase of the governor's STEM Task Force work, in 2014, this working group reviewed best practices of Personal Learning Plans locally, regionally, and especially those leading to relevant STEM careers that are offered in Career and Technical Educational Centers.

In this second phase of the STEM Task Force, the working group focused on gathering data to create implementation plans by asking school administrators, teachers, parents, educational organizations, and business leaders from around the state during extensive interviews, "What can we do to better prepare middle school students for STEM careers after high school and college?" Highlights from those interviews are included under "Next Steps." The working group also proposed that a pilot be implemented in a middle school setting in order to test some of these recommendations.

Proposed Pilot. In the fall of 2017, the PLP working group will apply several recommendations drawn from interviews conducted throughout the state. The first pilot is proposed for the Lebanon Middle School in Lebanon, NH, in partnership with Hypertherm,[9] which is also located in Lebanon. The working group is also seeking other middle schools throughout NH as additional pilot sites once the Lebanon pilot has been tested. Specific ideas for the Lebanon pilot include:

- developing a partnership between Lebanon Middle School and Hypertherm in order to offer a February vacation STEM camp, and a "STEM morning" at Hypertherm including a tour, interactive presentations on STEM careers, and time for middle schoolers to reflect on their impressions of the experience;

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[8] Teachers report that eighth graders regret not having had the opportunity to explore career options earlier in their schooling.

[9] Hypertherm, an international company headquartered in Lebanon, NH, designs and manufactures advanced metal cutting products for use in such industries as shipbuilding and oil and gas.

- implementing a Job Shadow Day and supporting after-school STEM programs;
- creating and implementing Extended Learning Opportunities (ELOs) tailored to each student, such as the current program in the middle school in Lebanon that offers one credit for studying advanced manufacturing awareness;
- investigating and potentially adopting for Beta testing a Personal Learning Plan platform such as Naviance or LiFT in order to engage students, parents, and educators in educational planning.

Next Steps. *(based on interviews conducted by Personal Learning Plans Advisory Committee).* Create experiential opportunities, such as career-based study lessons[10] and Extended Learning Opportunities based on competency-based instructional models, in order to enable students to explore a wide range of career opportunities.

- Require reflection for capturing and cataloguing the thoughts, passions, and goals of students as they move through their Personal Learning Plans. Reflection is an essential part of the experiential activities.
- Look at existing partnerships throughout NH in which local businesses are bringing middle schoolers into their facilities for tours, career exploration, job shadowing, and after-school programs that can be replicated at any middle or elementary school using community and business partners as teachers.[11]
- Expand volunteer support by using older students as advisors to younger students. This approach gives additional support to school counselors, parents, and members of the business community.[12] Also, consider inviting all school staff, regardless of job or rank, to participate in the counseling process, as is the practice at SAU#17.
- Create regional career fairs for middle school students.
- Offer summer, vacation, and school break STEM camps as a low-intensity way to encourage engagement and exploration with PLPs.[13]

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[10] Examples include the Little League of Manufacturing, Gateway (Project Lead the Way), and Possible Future Possible Selves (PFPS) for middle schoolers.

[11] Hypertherm (with project leader George Caccavaro) is an example of a business supporting after-school STEM programs for elementary and middle school students. Businesses serving as after school mentors and teachers fall in line with the Blue Ribbon/Gold Circle Awards via NH Partnerships with Education; see http://www.nhpie.org/awards.html .

[12] Other states have had success using older students to counsel younger ones, it has made a positive difference; see for example the Rhode Island Office of Multiple Pathways.

[13] Hypertherm/Lebanon schools are developing a STEM camp for February 2017 school break. Hypertherm has had an eight-week summer school program for the past two years.

- Offer teacher and school counselor externships to heighten awareness of STEM jobs today, since most teachers move from college training directly into the classrooms and therefore lack an understanding of business experience.
- Use online opportunities like "virtual job shadow" and "MentorConnect.org" to connect students with high tech jobs and actual mentors in those fields.

Once there is proof of concept for Personal Learning Plans, focus can turn to the current middle school approval standards and ensuring that policies support career and academic planning for all middle school students. Parallel to this, resources should be identified, developed, and deployed as part of a statewide effort to ensure that school districts and students across the state can effectively engage in personal learning plan efforts.

Inspiring Students

Recommendation:[14]   Create New Hampshire Math and Science Academy

Background and Goals. Following the release of the Task Force report a working group was formed to explore the feasibility of creating the NH Math and Science Academy NHMSA). In public discussions with the Task Force membership as well as in small-group and one-on-one discussions with NH students, K-12 and higher education faculty and administrators, and employers, the Task Force identified as NHMSA goals headline-worthy increases in

- NH students entering STEM bachelor degree programs;
- low-income, first-generation-college, and underrepresented students in NH STEM bachelor degree programs;
- NH college graduates entering NH STEM fields.

Though no assumptions were made about NHMSA design, the Task Force did identify features that should be part of any such design:

- preparing high school students for success in earning a STEM bachelor's degree or higher;
- serving students throughout NH;
- targeting untapped STEM talent in under-represented populations, including low-income and first-generation-college students who lack access to STEM studies, thereby promoting both economic progress and social mobility for NH citizens.

As a step toward furthering these goals, the Task Force planned and hosted a NHMSA Design Day at Southern NH University's Sandbox on April 25, 2016. Twenty-five NHMSA stakeholders and two outside experts were recruited to participate (see Appendix D). In preparation, all participants were asked to interview at least one representative of each key stakeholder group, namely students, parents, and NH employers of STEM graduates. In order to capture a mix of demographic perspectives, participants included parents and students from across the socio-economic spectrum. The student interviews captured the experiences of those aspiring to STEM bachelor degree programs; the parent interviews collected information in an effort to assess their children's interest in aspiring to STEM bachelor degree programs; and the employer interviews recounted hiring practices and responses to employing those with STEM bachelor's degrees. On Design Day,

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[14] This was recommendation #4 in the 2015 STEM Task Force Report

participants synthesized the interview take-aways, focusing on specific problems in STEM education revealed by the interviews. Participants recommended that the proposed NHMSA:

- place less emphasis on testing, allow room for failure, and celebrate struggle;
- attract teachers who are interested in and passionate about teaching STEM in new ways;
- cultivate learners who are curious about open-ended STEM questions in both real-world and abstract settings;
- develop students' confidence in STEM settings, rather than weeding them out of the STEM pipeline;
- teach students that STEM problems often have more than one solution;
- foster and encourage STEM curiosity and the application of that knowledge;
- support and inform first-generation-college students about STEM opportunities;
- register on the radar of elementary and middle school students;
- encourage collaboration and project-based learning;
- provide students with the social capital[15] to persist and succeed in STEM subjects.

Actions and Achievements. Based on these and other interview takeaways, participants identified Academy design options. In order to serve students from throughout the state, participants suggested that NHMSA adopt a decentralized model with satellite programs throughout the state. In order to direct most of NHMSA's efforts toward STEM enrichment activities, NHMSA students would remain enrolled in their current high schools (where they have access to non-STEM subjects, sports, and other aspects of the high school experience) while committing to participate in a two-year intensive STEM program at their local NHMSA satellite site. Existing NH colleges and universities could serve as satellite NHMSA sites, emphasizing one or more specific STEM concentrations depending on each institution's strengths and interests.

Students would enroll in the two-year NHMSA certificate program during their sophomore and junior years of high school, culminating in and coinciding with the college application process. NHMSA admission criteria should emphasize the personal attributes necessary for success in STEM subjects, namely passion,

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[15] Social capital refers to the networks of relationships among people who live and work in a particular society.

persistence, and grit, rather than test scores. Evidence of these attributes may be evaluated in either academic or nonacademic settings. Students who enroll in NHMSA would be expected to make the same level of commitment required in a high school degree program, and those who fail to meet the minimum level would be dismissed from the program. Though NHMSA satellite sites might focus on different STEM fields and specializations, all NHMSA satellite programs would adopt a shared set of learner outcomes (which are still to be determined).

NHMSA students would also be eligible to earn early college STEM credit on their satellite campuses at no cost. Students who successfully earn the NHMSA certificate at the end of their junior year of high school would be invited during their senior year to serve as peer mentors for current NHMSA students. All NHMSA students enrolled in satellite programs throughout the state could come together twice each year for an intensive, one-week, low-residency component. The low-residency component, which may be offered during a school vacation, could include mini-courses in vital STEM areas, guest lecturers by STEM industry professionals, mentoring by STEM faculty and undergraduates, STEM problem-solving workshops, and STEM-focused college fairs with representatives from NH colleges and universities.

Next step. The NHMSA working group will prepare a feasibility report that can provide a framework for planning and funding the NH Math and Science Academy by the end of 2016.

Inspiring Students

Recommendation:[16] Motivate innovative approaches to Career and Technical Education and introduce new STEM Pathways

Background and Goal. This working group acted on the STEM Task Force recommendation to motivate innovative approaches to Career and Technical Education (CTE) and introduce new STEM pathways. Currently, there are multiple initiatives underway in NH that focus in some way on developing such career pathways in applied STEM areas as advanced manufacturing and information technology. Examples of these initiatives include the Smarter Pathways Project, which is run through the New Hampshire Charitable Foundation (NHCF), the Guided Pathways Project, run through the Community College System of New Hampshire (CCSNH), and the partnerships between NH-CTE and the CCSNH to offer dual credit programs through Project Running Start, in which students can earn multiple college credits with degree and certificate programs in STEM fields.

Efforts are ongoing between the Community College System of NH and high schools and CTE centers across the state to allow students to take Running Start dual enrollment and Early College courses in STEM academic and technical fields including math, biology, mechatronics and computer programing. Work is being done to have these courses be part of more seamless and better supported pathways to accelerated completion of STEM post-secondary degrees and to increase the retention of talented young adults in NH.

Students on the STEM pathway from NH high schools to CCSNH will be able to transfer to programs at University System of NH (USNH) institutions. The two public systems have committed to doubling the number of STEM post-secondary degrees awarded by 2025 and have established strong articulation agreements and pathways in several STEM programs with more to follow.

Recently, the NH Department of Education (NHDOE) received a $100,000 grant through the New Skills for Youth Initiative (NSFY) to develop a plan to enhance career readiness and seamless career pathways for NH students. Other relevant pathway initiatives exist within the context of the Department of Labor (DOL) apprenticeship programs and the Sector Partnership initiative (SPI). A recent grant was also secured from the National Governor's Association (NGA) to focus on developing and improving work-based learning opportunities in New Hampshire.

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[16] This was recommendation was also part of #4 in the 2015 STEM Task Force Report

Goal: a common statewide initiative and definition. The momentum behind and demand for STEM pathways for students and workers in NH continue to build. Excellent work is going on throughout the state; however, these efforts need to be coordinated so that redundancies are avoided and all initiatives can be integrated. The development of a common definition and language for career pathways would be an important first step in organizing these efforts. Ultimately, a statewide system of collaboration and communication is required so that all vested parties and stakeholders are aware of the work taking place. The end-users, students and parents, will benefit most from a coherent, well-articulated pathway system for STEM.

Suggested actions and next steps.

- Develop a series of STEM-focused career pathways that begin in high school and provide opportunities for students to move seamlessly from secondary to CCSNH and then into STEM-related careers in NH or transfer to four-year program at a USNH institution.
- Develop or enhance statewide advisory boards within specific pathways (e.g., IT, advanced manufacturing, healthcare, HVAC, electrical technology) to guide the development of STEM pathway curricula and course sequencing so that students and workers are well prepared for entry into the workforce. Increasing the involvement of the business community will be an essential component of this work.
- Create more STEM early college opportunities for high school juniors and seniors to complete college work on the campuses of the CCSNH. This effort can broaden the opportunities for students who do not have easy access to CTE programs and provide cost-effective alternatives to expensive CTE programs.
- Create high school experiences that combine high school, community college, and work-based learning experiences for students. Students would potentially graduate with a high school diploma as well as a two-year associate degree or certificate as well as participating in a work-based learning experience.
- Develop a mechanism for the communication of exemplary STEM pathways, initiatives, and work-based learning opportunities in development or in practice so that the necessary stakeholders (CTE Directors, principals, school counselors, students, and parents) will be aware of the resources and programs available.

The NSFY initiative has the potential to serve as the galvanizing initiative for efforts related to STEM pathways. Ultimately, a K-employment pathway system for New

Hampshire should be the goal. This systems approach would include improved teaching and emphasis on STEM in the early grades and access to STEM academic and work experiences that inspire students to enter pathways that prepare them for advanced studies and near-seamless transition through the education system and into NH employment. Exposure to STEM careers and pathways should be a priority for middle school career exploration so that students are well positioned to enter STEM Pathways during their high school years.

P-TECH: An intersection between career and academic preparation. At the intersection of the Task Force's recommendations on Career and Technical Education and the NH Math and Science Academy (and addressing suggested action bullet number four above), the Task Force encourages efforts to bring the nationally recognized P-TECH (Pathways in Technology Early College High School) program to NH. Pathways in Technology Early College High School (P-TECH) is a new type of school (or program within a high school or community college) that brings together the best elements of high school, college, and the professional world. P-TECH enables students to begin their college and professional lives more quickly and with more support than the typical school-to-work pathway. Students at P-TECH programs benefit from partner company mentors, instructors, and internship and project activities, guided curriculum paths from education to careers in growth industries, and early college opportunities. Graduates of P-TECH have the opportunity to earn associate degrees and to leave school with the skills and knowledge they need in order to continue their studies or to step seamlessly into competitive jobs in information technology (IT) or another STEM-related industry.

 The STEAM Ahead program with Dyn and Silvertech as industry partners could be developed into a P-TECH model at Manchester West for IT, and there may be opportunities for programs involving Fidelity Investments and Liberty Mutual for IT-finance/insurance industry pathways. Dartmouth-Hitchcock is an interested partner in health-IT focused program and Hypertherm is an interested partner in advanced manufacturing. Members of the STEM Task Force met with Stanley Litow, the President of the IBM Foundation, to discuss bringing the P-TECH program to NH. The IBM Foundation is the major national supporter of P-TECH and is interested in working with NH, being willing to come to the state to put on a high-level workshop and planning session about P-TECH and to help bring industry partners into the discussion.

Inspiring Students

Recommendation:[17]   Engage and Mentor Girls for Careers in STEM

Background and Goals. The goal is to increase the academic and career pathway opportunities and support for girls in STEM. Realization of this goal requires not only increasing the number of STEM-related activities for girls and young women, but also requires a systematic approach to address barriers to their advancement in these fields. To advance this mission, the Girls in STEM working group outlined three immediate goals:

- expand Girls in STEM programs into elementary schools and new regions of the State;
- create a virtual online "hub" for information-sharing and recruitment of mentors for girls;
- expand STEM for girls' professional training as educators and administrators.

Actions and Achievements.

- *Students*

  The Girls in STEM working group focused on creating collaborations intended to increase resources and sustainable programming for girls. In November 2015, Governor Hassan declared Girls in Technology week, during which 89 STEM women leaders organized by the NH High Tech Council's Women/Girls in High Tech led career forums with ninth grade girls throughout the state. Additionally, the Department of Education in cooperation with the NH Institute of Technology and Manchester Community College hosted more than 800 ninth graders for Girls in Technology Day. Further, the working group encouraged and supported local development of four STEAM model programs for girls in elementary schools in four regions of the state (Learniverse Quinks at www.learniversellc.com)

- *Teachers and Districts*

  During the year, the working group developed plans for three year-long professional development programs to be offered statewide beginning summer 2017. These programs will include continuous follow-up by the Dartmouth Office of Science and Technology Outreach and Crossroads Academy. Professional development was designed in collaboration with the American Association of University Women (AAUW), the National Girls

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[17] This was recommendation #6 in the 2015 STEM Task Force Report

Collaborative Project, and experts in gender equity with the specific goal of addressing teacher implicit bias and micro-messaging within the context of building specialized content knowledge in STEM education.

- *Parents and Community*

With a new partnership between the Dartmouth Office of Science and Technology Outreach office and the AAUW, NAPE, and the National Girls Collaborative project, a virtual "online" hub was created to enable girls to share information about upcoming programs, challenges, and successes. The hub is an important step in building a support and communications network.

Additionally, the hub houses a virtual mentor database that provides mentor training modules on how to coach girls in their exploration of STEM. This database will be expanded not only to increase access to STEM opportunities for girls of all ages, beginning in elementary school, but also to connect with a wide array of industry mentors. Virtual mentor training is also being developed, as is similar support through a virtual network in order to reach out to parents and built awareness of STEM. [18]

- *Higher Education and Research*

An important element in the development of programs is to encourage the integration of STEM and the arts (STEAM) and the creation of workable evaluation models, which were established in 2015. The group also elaborated a three-year plan to collect multiple forms of data following the creation of evaluation tools specifically designed to assess girls' awareness and interest in STEM, their self-motivation and the potential for use in longitudinal tracking and comparisons of STEAM programs within NH and nationally (funded by the AAUW).

The Dartmouth Office of Outreach is beginning a new study on gender equity in STEM in collaboration with the Gender Institute at Dartmouth. This study complements and builds upon recent collaborations with Historically Black Colleges and Universities in the effort to understand the complex and interrelated factors that impact girls' experiences along STEM pathways and looking beyond the sole factor of gender. There has also been a reactivation of work previously initiated in NH by the National Alliance for

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[18] Based on the result of recent key research on the key role of parents in building STEM awareness and interest for girls (see the following for further information).
https://news.microsoft.com/download/archived/presskits/citizenship/docs/STEMPerceptionsReport.pdf

Partnerships in equity that ended in 2011 (see http://www.napequity.org/nape-content/uploads/REPORT-SUBMITTED-TO-NSF-ON-04-26-13.pdf).

Next Steps.

- Girls Technology Day will expand north to Dartmouth College in the spring of 2017.
- Proposals will be developed to increase funding through a partnership with the AAUW through the Community Action Grant, which will allow for high-need areas to increase after-school and summer programming designed for girls, such as the Tech Trek and Tech Savvy programs.[19]
- New programming opportunities will be offered through a partnership with the National Girls Collaborative Project, including the coordination of activities and support for services related to motivating and fostering girls' interest in STEM careers (the National Girls Collaborative Project now has a partnership with the Dartmouth Office of Science and Technology Outreach). See https://www.dartmouth.edu/~academicoutreach/
- Continued partnerships with three districts (Manchester, using specifically STEAM Ahead, as well as Hanover and Lebanon) to design a P-12 model of best practice in STEM education as well as to identify, analyze, and build new opportunities for girls and professional development specific to addressing teacher implicit bias and micro-messaging.
- Developing the NH Girls in STEAM hub database, which will connect to one of the largest national virtual hubs of girls programming.[20]
- A series of training modules for mentors and parents will become publicly available by October, 2016.

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[19] See http://www.aauw.org/what-we-do/stem-education/tech-savvy/ for further information.
[20] See https://ngcproject.org/node/149/programs for further information.

Inspiring Students

Recommendation:[21]   Focus on Competitions

Background and Goals. FIRST®[22] was highlighted in the original Task Force report as an example of a successful STEM competition that had proven results. FIRST fills an important aspect of STEM learning by providing hands-on opportunities for student engagement. In addition, FIRST covers the full range of K–12 learning and is already supported by local and national organizations, though lack of sufficient funding hampers its expansion on a statewide level in NH. To move forward, this working group adopted two goals:

- to create a plan for all school districts in the state to participate in at least one level of FIRST competitions, especially at the critical middle school level and
- to secure sustainable funding through private enterprise to support one coach per school, at a cost of $300-$500 each, and to buy a one-time only FIRST competition kit.

Actions and Achievements. Follow-on discussions with FIRST identified their Tech Challenge program as the optimal level (which includes the key middle school level) on which to focus NH STEM competitions. The following actions have already been taken:

- securing a plan for a gubernatorial proclamation that names FIRST Tech Challenge as the first official NH STEM competition;
- commencing negotiations with superintendents and school boards about providing local school districts with funding for one Tech Challenge coach ($300-$500) and seeking matching grants to assist local school districts;
- initiating a recruitment effort to find a statewide business partner to fund Tech Challenge start-up kits for schools (the estimated cost of this initial effort is $150,000).

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[21] This was recommendation #3 in the 2015 STEM Task Force Report

[22] For Inspiration and Recognition of Science and Technology (FIRST) is an international youth organization that operates the FIRST Robotics Competition, FIRST LEGO League, FIRST LEGO League Jr., and FIRST Tech Challenge competitions.

Next Steps.[23]

- Create legislation to declare FIRST as an official "NH" STEM-Inspiration program.
- Develop and secure sustainable funding for at least one FIRST Tech Challenge team in every NH public high school.
- Encourage local school districts to provide stipends to FIRST coaches.
- **NHSEE.** Science fairs are a tried and true method for challenging students to excel in multiple subject areas. The NH Science & Engineering Expo (NHSEE) is a national, corporate sponsored fair that allows students to compete in a wide variety of STEM areas from Behavioral Science to Biology and Engineering. The challenge is that the NHSEE struggles to obtain annual funding, not only for basic operating costs, but also for funding for students to travel and compete in national completions. The Task Force has discussed expanding STEM competitions to include partnerships such as these.

Next Steps.

- NHSEEE will establish $30,000 annual funding for its operating expenses. Private donors will be sought to fund an annual $50,000 scholarship fund (at $10,000 per student for up to five students) that will fund eligible state-level winners to compete in the national competition.
- Incentives will be created for local school districts to support teacher mentors for NHSEE student entries, including transportation of students to the annual statewide competition.

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[23] Although the Task Force recommends building participation in FIRST, the Task Force fully supports and endorses all age-appropriate competitions that encourage NH students to develop strong academic-based STEM competencies. The Task Force website (in development) will provide information on NH competitions.

Empowering Teachers

Recommendation:[24]   Teacher professional development for STEM excellence

Background and Goals. The 2015 Task Force report pointed out that increasing the number of students ready for STEM careers necessitates increasing the number of STEM-competent teachers. NH is fortunate to have outstanding educators, however, relatively few are strongly prepared to teach STEM courses, especially in math and science. A broader array of professional development and credentialing options is needed, and the Task Force accordingly issued the following recommendations.

- The NH Department of Education should create a position of state director of STEM to coordinate district efforts to coach and develop teachers in STEM subjects and to encourage local districts to appoint STEM coordinators.
- The Department should establish alternatives to traditional teacher credentialing and professional development, such as stackable credits for short-term study (micro-credentialing), particularly for coding and computer science, while for general education teachers (K-5) a special pathway should be created for specialties in math and science.
- The regional Local Education Support Center Network (LESCN) teacher professional development network, which currently operates with infrequent or no collaboration, should be reactivated so that teachers, especially in rural areas, may have access to such local resources as STEM curriculum kits, Makerspace labs, and shared professional development training, both online and in face-to-face groups.

Actions and Achievements.

- In 2015, the New Hampshire Department of Education appointed a state STEM coordinator, and throughout 2015-2016 some school districts created similar positions at the local level.

- New and non-traditional approaches to credentialing and professional development are being explored. A member of the Empowering Teachers working group represents NH on the Council of Chief State School Officers (CCSSO) national consortium "Network for Transforming Educator Preparation" (NTEP), which works to create new options (known as career lattices) for teachers to remain in their classrooms while advancing their

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[24] This was recommendation #8 in the 2015 STEM Task Force Report

careers as teacher-leaders. The NTEP will issue recommendations in June 2017, in time for the 10-year review of teacher credentialing standards by the NH Department of Education.

- The Empowering Teachers working group hosted several conference calls with regional LESCN directors in which ideas for STEM professional development collaborative projects were established. (See APPENDIX E). More conferences are slated beginning fall 2016.

Next Steps.

- Continue work with the NTEP to develop a framework for credentialing and micro-credentials.
- Support the NH Department of Education's STEM professional development activities.[25]
- Convene LESCN centers for discussions about possible collaborations for shared STEM professional development training.

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[25] The NH Department of Education has instituted a series of STEM K-12 professional development opportunities for teachers and administrators throughout the state. For example, in fall 2016, the Department of Education will co-host with the University of New Hampshire/Manchester statewide professional development training on the teaching of computer science for NH K-12 educators. These events are a continuum of ongoing professional development including a STEM strand at the 2016 NH educator' summer summit and an upcoming STEM spring educator summit in 2017 led by the Leitzel Center and the Teachers' Collaborative at UNH.

Communications and Engagement

Recommendation:[26]   Develop a virtual web hub for STEM information

Background and Goals. Lacking a hub to serve as a central repository for STEM career and educational information, the original Task Force called for the creation of a website to house this critical data, which is especially important for rural districts without ready access to STEM resources.

Actions and Achievements. The Communications and Engagement working group held user experience interviews with parent-teacher student teams, teachers, and technology support staff to determine needs for a website. In addition, the group collected state and national data, learning that different stakeholders in STEM education had different needs for the virtual hub, which was then redesigned accordingly. A STEM website will be built by the state STEM coordinator in fall 2016, and long-term support for maintenance has been secured.

Next Steps. Create STEM TF website by September 1, 2016. The state STEM Coordinator will develop a 1.0 basic website that can be expanded upon.

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[26] Communications and Engagement was added as a new working group for this Task Force.

Conclusion

New Hampshire's economy and educational institutions have many strengths including in STEM. Yet, there are contradictions that limit economic growth and the advancement of economic opportunity. It has been well documented that NH's economy is favorably positioned for growth across a range of industries with a high demand for STEM educated workers. Many STEM-related job vacancies, however, go unfilled increasing the state's vulnerability to slowed economic growth. And, while workers in STEM-related employment earn on average well above the statewide average and enjoy rewarding career opportunities, many in the NH labor force are employed in positions in which they feel unfulfilled and unable to provide their families with the quality of life that they deserve.

Strengthening STEM education and STEM education-to-STEM-career opportunities is a way to address these contradictions in the state economy and workforce while at the same time reinforcing the knowledge base and foundations for educational excellence and citizenship. The activities described in this report build on the existing foundations within STEM education in the state. With these actions, the state is advancing STEM K-12 education in substantial ways, and over time the stronger STEM education pathways in NH will strengthen the social and economic future of the state and its residents.

The Task Force members appreciate having had the opportunity to address NH's STEM K-12 Education. Many of the pieces of the STEM K-12 Education system are in place, but they need to be further strengthened, interconnected, and resourced. Local efforts led by K-12 teachers and staff and community leaders are critical. At the same time, sustaining the efforts of the Task Force and STEM education in general will require continued leadership statewide. The STEM Task Force has served in this leadership capacity. Going forward, it will be important to maintain cooperative leadership in STEM education that is coordinated across the sectors of education, industry and government.

Appendix A

Recommended Topic Outline, Introduction to Coding Course

DESCRIPTION

This course is an introduction to coding and software engineering for all students interested in developing software applications in a variety of fields. This course will also satisfy a mathematics elective.

The course will use a project-oriented approach. Students will collaborate in a hands-on approach to learn problem solving, coding, debugging/troubleshooting strategies, data structures, and algorithms. They will explore a variety of programming systems and languages to create interactive applications and systems. Students will work on projects (both individual and team) in the areas of graphics and games, animation and art, electronics systems, and interactive fashion using appropriate software.

PREREQUISITES

Basic familiarity with computers and software applications, plus an innate curiosity.

OBJECTIVES

Upon successful completion of this course, students should:

- Understand basic principles of thinking and solving problems with computers and computation.
- Be able to specify procedures for solving problems and the concepts and practice of designing and implementing algorithms.
- Recognize, analyze, and correctly use the basic elements of computer programs, such as statements, variables, events, conditionals, loops, timers, and arrays.
- Grasp and utilize the fundamental concepts of computer science including data types, control structures, operators, and functions.
- Have a working knowledge of computer system design and the practice of software engineering, software tools, debugging, and documentation.
- Be able to design, plan, prototype, implement, test, and document a reasonably complicated software and hardware project.

TOPICS   A summary of the units of study and topics for the course is listed below. Detailed information about assignments and assessments may be found on the course website, as noted below.

Unit	Topics	Duration
Discrete Math Topics	Sets and counting Graphs and trees Boolean logic Discrete probability	3 weeks
Computational Thinking	Problem Solving System Design Algorithms	1 week
Elements of Programming	Control Flow Iteration Variables Events Conditionals Timers Arrays	3 weeks
Computer Science Fundamentals	Data Types Control Structures Operators Functions Libraries	3 weeks
Software Engineering	Software Design Programming Tools Debugging Documentation	3 weeks
Final Project	Concept & Proposal Design Documentation Project Plan Prototype Implementation User Testing Communication	5 weeks

Appendix B

Resource List, Coding in Early Childhood

The following are resources and guidelines for school districts and teachers interested in learning more about incorporating STEM into the classroom:

Tufts University Graduate School of Arts and Sciences is offering an Early Childhood Technology Certificate Blended Online and On-Campus Program. According to the organization's website this will be launching in September 2016, go.tufts.edu/ECT.

New Suite of STEM Tip Sheets and Resources for Families and Early Educators. According to their website, "The US Dept. Education, the Dept. of Health and Human Services have partnered with Too Small to Fail to create a set of early STEM resources for families and educators of young children called Let's Talk, Read and Sing about STEM!," and http://www2.ed.gov/about/inits/ed/earlylearning/talk-read-sing/index.html?utm_content=&utm_medium=email&utm_name=&utm_source=govdelivery&utm_term=

The Early Childhood Robotics Network, which has curriculum, assessments, videos and lots of pictures for early childhood teachers working with KIBO robotics: http://tkroboticsnetwork.ning.com

ScratchJr - According to the organizations website, this is a "collaboration between the DevTech Research Group at Tufts University, the Lifelong Kindergarten Group at the MIT Media Lab, and the Playful Invention Company." More information can be found at http://www.scratchjr.org.

KIBO robotics website: http://ase.tufts.edu/DevTech/ReadyForRobotics/index.asp

Coding and Programming with Primo - http://www.techandyoungchildren.com/coding-and-programming-with-primo/

Programming in the early years - http://www.techandyoungchildren.com/programming-in-the-early-years/

ReadyNation's STEM brief: http://readynation.s3.amazonaws.com/wp-content/uploads/ReadyNation-STEM-Brief-endnotes.pdf

Code.org®, a non-profit dedicated to expanding access to computer science, and increasing participation by women and underrepresented students of color. http://www.code.org

"Coding Class, Then Naptime: Computer Science for the Kindergarten Set," Anya Kamenetz, NPR, September 18, 2015 (includes recommended coding programs) available at: http://www.npr.org/sections/ed/2015/09/18/441122285/learning-to-code-in-preschool

Early Childhood Science Education Position Statement, from the National Science Teachers Association (focuses on preschool): http://www.nsta.org/about/positions/earlychildhood.aspx

"Turning Three-Year-Olds into Scientists," Alexandra Ossola, Atlantic Monthly, Nov. 5, 2014. Available at: http://www.theatlantic.com/education/archive/2014/11/turning-3-year-olds-into-scientists/382304/

"Having a Great Science Conversation with a Kid," Marie-Claire Shanahan, Scientific American, October 12, 2011, http://blogs.scientificamerican.com/guest-blog/having-a-great-science-conversation-with-a-kid/

Science Knowledge and Skills Toolkit for Professional Development, Head Start http://eclkc.ohs.acf.hhs.gov/hslc/tta-system/teaching/practice/curricula/SKandS.html

Erikson TEC Center Technology in Early Childhood - Introducing STEM into Early Childhood: http://teccenter.erikson.edu/show-me-videos/tec-teacher-takeaway-introducing-stem-into-early-childhood/

Center for Early Education in STEM which according to the organization's website includes, "Math games, by age group, including suggestions for adapting commercial board and card games," http://www.uni.edu/ceestem/games

Math at Play website: http://mathatplay.org/index.html

Erikson Early Math Collaborative: http://earlymath.erikson.edu/

Mathematics Knowledge and Skills Toolkit for Professional Development, Head Start http://eclkc.ohs.acf.hhs.gov/hslc/tta-system/teaching/practice/curricula/mkands.html

Boston Children's Museum STEM Sprouts: Science, Technology, Engineering, and Math Teaching Guide: http://www.bostonchildrensmuseum.org/sites/default/files/pdfs/STEMGuide

"STEM in the Early Years," Lilian Katz, http://ecrp.uiuc.edu/beyond/seed/katz.html

Non-Task Force Contributors to this report

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Dr. Joanne Roberts, Superintendent of Lebanon Schools

APPENDIX D
NH Math and Science Academy Design Day Host and Participant List

Hosts:

- Susan D'Agostino, SNHU Associate Professor of Math, NH STEM Task Force Member
- Martha Parker, Educational Policy Consultant NH STEM Task Force
- Michelle Weise, Executive Director of SNHU's Sandbox ColLABorative
- Patrick Moran, Deputy Director of Research of SNHU's Sandbox ColLABorative

Participant Name	Title/Affiliation
Paul Leather	NH Department of Education Deputy Commissioner of Education
Michael Evans	SNHU Vice President Academic Affairs
Ray McNulty	SNHU Dean of the School of Education
Steve Johnson	SNHU Associate Dean of the School of Arts and Sciences
Aaron Collins	SNHU Assistant Professor of Chemistry
Alycia Miner	SNHU undergraduate math education major & future math teacher
Beth Doiron	CCSNH Director of DOE and College Access Programs
Joseph Helble	Dartmouth Dean of Engineering
Vicki May	Dartmouth Associate Professor of Engineering
Petra Taylor	Dartmouth Professor of Engineering
David Webb	Dartmouth Professor of Mathematics
Luke Shorty	Maine School of Math and Science Executive Director
Kathi Mullen	UNH Manchester Vice Provost for Strategic Initiatives
Mike Decelle	UNH Manchester Dean
Cynthia Vascak	Plymouth State University Dean of Arts & Science
Osama Taani	Plymouth State University Chair of the Math Department
Natalya Vinogradova	Plymouth State University Director of the NH Impact Center
Ari Betof	Boston University Academy Head of School
Palligarnai Vasudevan	UNH Interim Provost/VPAA/Professor of Chemical Engineering

Sally Jean	Keene State College Professor Chemistry & Chemical Education
Brittany Weaver	Policy Advisor to Governor Hassan
Bill Furbush	Cooperative Middle School Principal, SAU 16, Stratham NH
Sophia Rubens	Cooperative Middle School 8th grader/future Exeter High School student
Lori Langlois	Executive Director of North Country Educational Services
Annie Wallace	Hampstead Middle School Math Specialist/NH Teachers of Math Rep.
Logan Kenney	NH Army National Guard Professional Engineer
Nicole Rosebush	Medtronic Senior Quality Assurance Manager

APPENDIX E

New Hampshire's *Local Education Support Center Network*

I.   History of the Professional development centers.

List of centers:

New Hampshire currently hosts five *Local Education Support Centers in this network*
http://www.lescn.org/Home

Additionally, also see URL below for information on New Hampshire Education Centers which include both LESCN and other professional development education centers not part of the original LESCN group.
https://docs.google.com/document/d/1f6cCJLCo1vY9t_kJwemt9_ytpcgCEZi3XQMFRZungow/edit

II.   REPRESENTATIVE SAMPLES OF STEM PROFESSIONAL DEVELOPMENT SERVICES OFFERED REGIONALLY IN NEW HAMPSHIRE. Text prepared by the directors of these Centers.

Lori Langlois: Director, STEM PD at North Country Education Services

Awarded through the Gorham Randolph Shelburne Cooperative School District, *Transforming STEM Instruction in North Country Classrooms* is a partnership of North Country Education Science, White Mountain Science, Inc., and the science department of Plymouth State University. Funded through the Math Science Partnership from the NH Department of Education, this three-year project began in October 2015 with a monthly series for two cohorts of 20 K-12 educators representing a mix from over 20 schools. The project approaches STEM with focus on integration through an engineering lens. Aligned with the NGSS engineering design framework, this means honing in on defining a problem, designing a solution, and optimization.

The second year of the project grouped the cohorts by grade span with the elementary educators implementing Novel Engineering in their classrooms (whereby students design engineering solutions for clients derived from dilemmas of storybook characters) and the middle/high group delving deeper into the skills, tools, and process of engineering design and analysis. In addition to the monthly professional development gatherings, there are supplemental workshops provided

on topics such as conducting scientific investigations and using "big data" in the classroom. Another feature of the project is co-learning design challenges that bring together a mix of high school students and teachers to work together on a design task such as building, launching, and recovering a high-altitude instrument to collect pictures and data.

As this project is grant funded, with the exception of the cost for optional graduate credits (offered at a significantly discounted rate), the professional development is provided at no cost to the participants or schools.

Further detail and project highlights at ncedservices.org/stem

NCES typically serves SAUs 3, 7, 9, 20, 23, 35, 36, 58, 68, 77 & 84

Jane Bergeron: Director, The Southeastern Regional Education Service Center (SERESC) and STEM *Center of Innovation and Excellence, Bedford, NH (not part of the original LESCN group. SERESC was created to serve educators serving students with disabilities).*

The Southeastern Regional Education Service Center (SERESC) is an education consortium that has been in existence for over 40 years and is one of the original regional consortia designed to support school districts and educators in servicing students with disabilities. Over the years all of the regional consortia have grown and evolved in differing ways. SERESC continues to specialize in support for unique learners, but has also expanded and become a professional development center offering statewide supports, technical assistance, and consultation in a wide range of areas to include but not limited to the following: early learning, afterschool program support, special education, technology, curriculum, instruction and accountability, creating school cultures that foster the health and well-being of all.

Over the past two years a priority for SERESC has been STEM education and the formation of a STEM Center of Innovation and Excellence. SERESC embraces the opportunity to support NH by inspiring educators and youth PK-12 by bringing forward support and professional development to address the recommendations outlined in the Governor's 2015 STEM Task Force Report. The SERESC STEM Center of Innovation and Excellence is a hub for coordinating, connecting, developing and offering innovative STEM professional learning opportunities. The Center not only sponsors professional development it also serves as an organizing point for school districts and large scale projects to help improve STEM integration in our schools. The Center brings together educators, business/industry, researchers

and funders for the purpose of strengthening STEM education and preparing NH's future work force.

Below is a sample of the professional development activities offered through the STEM Center of Innovation and Excellence over the past two years:

- Leading for Change in STEM Education, Building Your STEM Toolkit One Classroom at a Time, and The Gateway Project with the Boston Museum of Science
- The STEM Innovation Network
- Summer Academies for Kids
- STEM Integration Professional Learning Series, including professional development opportunities in school settings

The average cost for participation in a yearlong STEM PD offering ranges from $500 - $975. The average cost for one day workshop is $200.

In order to offer these professional learning opportunities, SERESC has partnered with the Boston Museum of Science, the Maine Mathematic Science Alliance, the University of New Hampshire (UNH) STEM Lab in Manchester, UNH Cooperative and the UNH Joan and James Leitzel Center. Additionally SERESC has conducted panel discussions with leaders in business and industry and in the planning stages are STEM educator field trips to businesses.

Steve Bigaj, Assistant Dean and Professor, School of Professional and Graduate Studies
and Beth Buoro, Director, Southwest Center for Educational Support at Keene State College

Southwest Center Summary and STEM Initiatives: The Southwest Center for Educational Support (SW Center) is the professional learning component of the Educator Preparation Programs at Keene State College (KSC). Our mission is to provide high quality, innovative professional development opportunities to educators in the Monadnock region and across the state. The SW Center collaborates with educators and schools across the region to implement professional learning opportunities at all levels. We offer a range of services, including workshops on a wide variety of topics featuring experts in the field, single or multi-day conferences, technology training, online courses, CEUs and/or graduate credits for professional development, support for professional learning communities, coaching, consulting and other professional learning, and collaborative grant proposal development.

Additionally, we support the NH Department of Education on various statewide and regional professional learning initiatives. See below for specific STEM professional development activities at KSC and STEM initiatives.

STEM Professional Development Activities at KSC

- The KSC Department of Math hosted the NH Teachers of Math (NHTM) Conference on 3/18/16.
- The Regional Center for Advanced Manufacturing (RCAM), a consortium of Keene State College, River Valley Community College, the Greater Keene Chamber of Commerce, and the Keene School District, in collaboration with the KSC Sustainable Product Design and Innovation program (SPDI) hosted a Makers' Symposium on 4/1/16. This event was designed to build awareness of maker space models, generate enthusiasm, learn more about regional needs, and create shared knowledge about maker spaces.
- Graduate credit options were offered by KSC for the NH Science Teachers Association (NHSTA) conference held on 4/2/16 in Derry, NH.
- The SW Center is currently exploring the possibility of offering regional training in the Gateway to Technology and Engineering Project (through the National Center for Technological Literacy/Boston Museum of Science).
- KSC Kids on Campus will be offering a Go STEM! program this summer. The full-week program is designed for girls and will involve learning about STEM with all of its cutting edge technologies. Hands-on activities will spark the curiosity to explore, discover, and achieve. This experience will provide tools and motivation for girls to engage in STEM related activities with an emphasis on team building, critical thinking, and real life problem solving. Participants will meet professional women role models and hear their stories about confidence and passion in pursuing STEM careers.
- The SW Center recently coordinated training for paraprofessionals in area school districts on the topic of Math Literacy.
- From 2012 through 2015, the NH Statewide Educator Summer Summit was hosted by the SW Center at KSC. STEM was one of six conference strands and an area of emphasis in 2015.
- The SW Center partnered with the New England League of Middle Schools (NELMS) and the Southwest Superintendents and Curriculum Directors groups to hold a regional conference on 10/9/15 that included the following breakout sessions: interdisciplinary teaching related to STEM, and integrating technology to create collaborative work platforms.

STEM Initiatives

- Dr. Steve Bigaj, Assistant Dean of Educator Preparation, is a member of the NH Department of Education, National Network for Transforming Teacher Education (NTEP) Steering Committee. The committee is examining issues and the development of micro-credential and certificate programs in support of educator development.
- The SW Center will be participating in a new partnership between the Cheshire Career Center and the New Hampshire Charitable Foundation and their Smarter Pathways initiative. This aligns with the Governor's Task Force on STEM Education and will address area workforce needs.
- From 2010 to 2013 the SW Center at KSC was a sub-award recipient of a NH Department grant project, The *Rural School Educator Effectiveness Collaborative: Bringing High Quality Professional Development to the Rural Schools of NH* (a State Education Agency for Higher Education (SAHE) Title II-A grant). Other partners on the project included Plymouth State University (lead partner), North Country Education Services (NCES), Granite State College, and New England College.
- (http://lhsgems.org/sitescenters.html) and curriculum from the Learning Design Group, a collaborative curriculum development and research program at UC Berkeley's Lawrence Hall Science (http://scienceandliteracy.org/ about/developmentprocess) that is being field tested in the Winchester School Partnership. The National Science Teachers Association Learning Center (http://learningcenter.nsta.org/) is also used as a tool to increase teacher candidate and Winchester staff content knowledge in science. The hope is that this effort will impact educators from our other partner schools, preservice teachers, KSC teacher educators, and K-6 students in the region.

Kathy Holt, *Director,* **the Capital Area Center for Educational Support (CACES)**

 The Capital Area Center for Educational Support (CACES) is a member of LESCN, the NH Professional Development Centers Network. Our mission is to provide our school districts with high quality professional development and resources that support their educational needs. CACES staff includes consultants, teachers, assistants and retired teachers and administrators who collaborate with LESCN to support NH DOE initiatives.

Our members include 24 school districts in the Lakes Region from Hopkinton to Deerfield and Newfound Area to Moultonborough. A listing is found on our website at www.caces.org under the "Partners" tab. CACES continues to support the initiatives of the NH Department of Education and works with other groups in

our region to support their efforts, including finding speakers, information and providing meeting space as needed.

As a non-profit, CACES strives to provide low-cost workshops. The cost for a 2-hour after-school workshop is $35.00 which includes all materials, and light refreshments; for a full-day session, the charge is $125.00 and includes materials, morning refreshments, and lunch. CACES has also provided off-site workshops at our member schools/districts to address professional development needs of large groups of teachers in the areas of technology and mathematics in the last few years. Rates for off-site sessions are determined by the number of participants and consultant fees.

In the past two years workshops have included the following sessions that support STEM concepts:

- Differentiating the Math Classroom Using Technology: Implementing CCSS Math Practices;
- CCSS Standards-Aligned Math Competency Grading;
- Next Generation Science Standards and the NH College and Career Ready Standards: How Do They Go Together?
- Online Tools to Implement Best Practices
- *STEAM Ahead: How Technology and The Arts bring Creativity to the Table*

CACES also provides a myriad of workshop sessions in technology education for teachers and support staff, such as iPad and Chromebook Basics, Google Basics, Google and Google Apps for Educators, Google Classroom, Apps for the iPad or Chrome, Google Research, Evernote, and Google Keep. These sessions build the technology skills of teachers for their own use (iPad and Chromebook basics); as teachers (Google and Google Apps for Educators, Google Classroom as a classroom management tool); to teach technology to students (Apps for the iPad or Chrome); and then most importantly, tools and techniques to build creativity, problem-solving, collaboration, etc. in students for their future as workers, citizens and family members (Google Research, Evernote, and Google Keep, and the iPad apps sessions with 21st century apps included.) Future plans include: seeking ways to enhance the STEM offerings we provide to our members by collaborating with regional groups such as the SEE Center in Concord, our partner IHE Plymouth State University, and other groups in our region.

APPENDIX F*

CS4NH Vision & Objectives

CS4NH Vision[27]

Our vision is for all students in NH to have access to a high-quality K12 progression of Computer Science (CS) educational opportunities, in order for them to learn concepts and practices that will empower [them] to…

- be informed citizens who can critically engage in public discussion on CS-related topics
- develop as learners, users, and creators of CS knowledge and artifacts
- better understand the role of computing in the world around them
- learn, perform, and express themselves in other subjects and interests

Core concepts and practices of CS[28]

Here are the 5 core concepts:	Here are the 7 practices:
1. Computing Systems 2. Networks and the Internet 3. Data and Analysis 4. Algorithms and Programming (Coding) 5. Impacts of Computing	1. Fostering an Inclusive and Diverse Computing Culture 2. Collaborating 3. Recognizing and Defining Computational Problems 4. Developing and Using Abstractions 5. Creating Computational Artifacts 6. Testing and Refining 7. Communicating

*Material provided for this Appendix by the NHDoE

[27] Adapted from: https://k12cs.org/faq/

[28] From: https://k12cs.org/faq/

CS4NH Objectives

1. Create opportunities for leaders to build consensus around the national Computer Science for All initiative and NH's CS4NH initiative.
2. Develop a K12 STEM Curriculum Framework that includes CS.
3. (A) Adopt or adapt CSTA K12 Computer Science Standards and (B) review school approval and graduation requirements.
4. Develop (A) curriculum, instructional guidelines, and (B) performance assessments for STEM, including CS.
5. (A) Create Computer Science teaching credentials and (B) develop preservice teacher preparation programs to grant them.
6. (A) Create CS micro-credentials and (B) develop inservice professional development towards these micros.

1. Consensus and collaboration

- Create opportunities for leaders to build consensus around the national Computer Science for All initiative and NH's CS4NH initiative.
- Leaders include:
    National leaders include the ECEP (Expanding Computing Educational Pathways) Alliance and the White House OSTP (Office of Science and Technology Policy).
    NH governmental leaders in educational policy development.
    NH and regional industry and nonprofit leaders in supporting K12 STEM education.
    NH higher education leaders in teacher preservice and inservice preparation.
    K12 leaders include representatives for professional organizations: NEA, AFT, NHSTA, NHTM, CSTA-NH, NHSAA, NHASP.
- Example:
    CS4NH Launch Day, Nov. 5.[29]

2. CS in STEM Framework

- Develop a K12 STEM Curriculum Framework that strongly incorporates CS.
- Components of NH STEM Framework:
    NH STEM mission and vision.
    Definition of STEM core concepts and practices.
    STEM program self-evaluation rubrics.
- Examples:
    NYC DOE STEM Framework.[30]
    Washington STEM Framework.[31]

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[29] More info at www.cs4nh.org
[30] http://goo.gl/BQerQl
[31] https://goo.gl/HVjfNm

3. CS Standards
- Adopt or adapt CSTA K12 Computer Science Standards.
- Review school approval standards and graduation requirements.
- About the K12CS Curriculum Framework and CSTA K12 Standards:

  K12CS Framework was developed by lead states (MD, CA, IN, IA, AR, UT, ID, NE, GA, WA, NC, NJ), large school districts (NYC, Chicago, San Francisco), technology companies (Microsoft, Google, Apple), organizations (PLTW, ISTE, MassCAN, CSNYC), and individuals (higher ed faculty, researchers, K-12 teachers, and administrators).[32]

  K12 CS Framework has been developed in coordination with updated 2016 CSTA K12 Computer Science Standards.
- Purpose of standards:

  Informs curriculum, instruction, and assessment.

  Informs credentialing, preservice education, and inservice professional development.
- Examples:

  Massachusetts Digital Literacy and Computer Science Standards[33]

  Indiana Science & Computer Science Standards[34]

  Arkansas Computer Science & Mathematics Standards[35]

4. Curriculum, Instruction and Assessment
- (A) Develop CS curriculum and CS PD curriculum for NH schools, students, and teachers
- (B) Develop performance assessments for STEM and Computer Science.
- Attributes of curriculum and assessments:

  STEM curriculum and instruction should be equitable and competency-based.

  STEM and CS performance assessments should include core concepts and practices as defined by framework and standards.
- Examples:

  NH PACE schools are piloting Performance Assessments for Competency-based Education.

  Work with PACE schools to pilot PAs for STEM and CS.

5. Preservice Education and Certification
- (A) Create CS credentials
- (B) Develop preservice teacher preparation programs to grant them.
- Purpose of CS credentials:

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[32] From: https://k12cs.org/faq/
[33] http://www.doe.mass.edu/stem/standards.html
[34] http://www.doe.in.gov/standards/science-computer-science
[35] http://goo.gl/Iz8pXS

Ensure that qualified personnel teach CS courses.

Inform the development of CS teacher preservice preparation programs.

Allow for candidates to become certified to teach CS via alternatives 4 and 5.

- Current work:

    Professional Standards Board is developing certification standards for Computer Science Educator (K-8 and 7-12).

    PSB will also consider incorporation of CS when renewing Science certifications (expiring 2017), and other relevant STEM certifications upon expiration.

    Several UNH-affiliated groups are collaborating to submit a proposal to Google K12 Education: Preservice Preparation RFP.

6. Inservice PD and Micro-credentials
- (A) Create CS micro-credentials and
- (B) Develop inservice professional development towards these micros.
- Current work in CS micro-credentialing:

    NTEP (Network for Transforming Educator Preparation) is umbrella for this effort which includes STEM TF, IHEs, and 2Revolutions (contractor with NHDOE).

    Developing Career Lattice system for teachers to develop expertise in high-need content areas, and be formally recognized for their efforts.

    Means of recognition include micro-credentials, graduate certificates, etc.
- Examples of Computer Science professional development.

    STEM and CS conferences[36]

    Integrated Math, Science, and Computer Science at NHTM, NHSTA, and CSTA conferences.[37]

    Computer-science focused PD at IHEs.[38]

    Nonprofit organizations.[39]

    Embedded PD at districts.

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[36] NH Educators Summer Summit (STEM Strand), Fall CS4NH Leadership Summit, Spring STEM Educators Summit

[37] NHTM and NHSTA have multiple annual conferences.

[38] Creative Computing Challenge, STEM Discovery Lab; NH CS4HS and Mobile CS Principles, STEM Discovery Lab; TeachCode, STEAM Ahead / MIT

[39] E.g.: Code.org, Project Lead the Way (PLTW).

Governor's Task Force on Science, Technology, Engineering and Math for K-12 Education

Dr. Ross Gittell, Chancellor, Community College System of New Hampshire, (Chairman)

REPRESENTS: COLLEGES AND UNIVERSITIES
Dr. Susan D'Agostino, Associate Professor of Math, Southern NH University
Dr. Joseph J. Helble, Dean, Thayer School of Engineering, Dartmouth College
Dr. Sally Jean, Chair, General Science Program**,** Keene State College
Dr. P.T. Vasudevan, Interim Provost and Vice President for Academic Affairs, University of New Hampshire

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Barbara Couch, President, HOPE Foundation, Hypertherm, Inc.
Jeremy Hitchcock, CEO & Chairman of Dyn

REPRESENTS: NH SUPERINTENDENTS' ASSOCIATION
Dr. Brian Blake, Superintendent of Schools, SAU #17

REPRESENTS: EARLY CHILDHOOD EDUCATION
Katie Brissette.], Deputy Director of SPARK

REPRESENTS: PARENTS
Joyce Craig, Manchester

REPRESENTS: CTEs
Chris Dodge, Director, of Career and Technical Education
Salem Career and Technical Education Center

REPRESENTS: NH DEPARTMENT OF EDUCATION*
Dr. Eric Feldborg, New Hampshire DoE, Director of STEM Education

REPRESENTS:: NH SCHOOL BOARDS
Robert Hallowell, Member, Nashua Board of Education

REPRESENTS: NH PRINCIPALS' ASSOCIATION
Todd Lamarque, Principal, Lancaster Elementary School

REPRESENTS: NH SCIENCE TEACHERS ASSOCIATION
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REPRESENTS: GIRLS IN STEM
Dr. Lauren E. Provost, Director of Science and Technology Outreach, Dartmouth College

REPRESENTS: THE NH TEACHERS OF MATHEMATICS (NHTM) ASSOCIATION
Annie Wallace

ADVISOR TO THE TASK FORCE
Tom Hassan, First Gentleman

REPRESENTS: GOV. HASSAN'S OFFICE, POLICY ADVISOR
Brittany Weaver, MPA

STEM TF CONSULTANT/ ADMINISTRATOR
Dr. Martha Parker-Magagna

*David Benedetto, the new director of STEM education, joins the Task Force September 2016. Dr. Eric Feldborg, the new Director of NH CTE and Bureau of Workforce Development, remains on the Task Force.