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

October 7, 2014

Manchester Community College, Manchester, NH

Task Force Members in Attendance: Ross Gittell, Chairman; Brian Blake; Barbara Couch (by phone); Susan D'Agostino; Robert Hallowell; Mary Kate Hartwell; Joseph Helble (by phone); Caroline Herold; Todd Lamarque and Paul Leather

Unable to Attend: Joyce Craig; Jeremy Hitchcock; Dean Kamen; Palligarnai Vasudevan

Others present: Mary Laturnau, Director of School Engagement, Project Lead the Way; and Tom Laliberte, Principal, Winnisquam Regional High School.

I. Call to order

Chairman Gittell opened the meeting at 4:00 p.m. by welcoming members of the Task Force and the public who were present at the meeting.

II. Approval of September 25, 2014 minutes

Robert Hallowell made a motion to accept the minutes. Dr. Susan D'Agostino seconded. The minutes were approved unanimously.

III. Items requiring discussion and approval

a. Review report format for final recommendations (see Addendum A)
b. Review revisions and updates to the following recommendations (See Addendum B)

Group 1: STEM Inspirations. Lead author: Joe Helble

- Amend NGSS language (suggested that it include reference to NGSS as a key recommendation of the TF). Objective: to avoid assumption that NGSS is required to adopt this program.
- Review number of references to FIRST -is this "first" among other competitions?
- Implementation: second bullet - insert high school (so reads middle school and high school)
- Girls in STEM: remove first paragraph. This paragraph will be moved to a separate discussion of girls in STEM. Second paragraph excellent as is.

Group 3: Innovations Hubs. Lead author: Robert Hallowell

- This recommendation helps to provide an infrastructure which NH will need to build out support to raise the number of STEM-qualified high school graduates. Mary Kate Hartwell volunteered to further develop the concept because she had recently completed

Research on other similar STEM hubs in other states. In some cases, as in Massachusetts, Innovation Hubs were connected to museums, colleges, business and industry – each with a different focus for students and teachers.

Task Force suggested that once the new recommendation is completed, they can determine if it should be a stand-alone recommendation or more effectively combined with another recommendation such as Early College Academies (recommendation 2).

- Action: Mary Kate will develop a draft recommendation by Oct. 11

Group 4: STEM Curriculum Integration. Lead author: Robert Hallowell

- Provide guidance to the reader in the recommendation overview as to what will follow in the recommendation

- Revise wording from "to create funds" to "use or increase existing funds" to support development of STEM labs (or conversion of Technology Education labs to STEM labs as appropriate). *Note: DoE has provided grant funding support for STEM labs in middle schools for past 12 years*

- Making time for STEM: Retain wording which supports science classes in elementary and middle school (a foundation of science is necessary before progressing to STEM study). Suggest that STEM experiences can be initiated through STEM labs (converted Tech Ed labs which are currently available in most elementary and middle schools).

- Consider adding a call for districts to prepare K-12 STEM plans as the first step. In these plans Districts could use their best case solutions for meeting STEM educational goals. For example, one district might choose to reshape an Ed Tech program around Next Generation Science Standards to meet STEM goals, while another might choose to create integration of STEM activities into math and/or English language Arts studies. Additionally, since K-8 (designated as "elementary" schools) do not have to meet current middle school science requirements (many due to limited resources), with a district-wide response to STEM student learning, K-8 schools might utilize high school resources, where appropriate.

Group 6: Teacher Preparation and Professional Development. Lead author: Caroline Herold

- Recommendation overview: Task Force suggests referencing the long-standing critical shortages of teachers in STEM fields and that this recommendation seeks to address this problem both in teacher credentialing and in professional development.
- Teacher credentials: Although State Board of Education (2013) raised requirements for the award of teaching credentials for elementary and middle school, the Task Force recommends strengthening requirements further to address needs in STEM fields. In particular, although New Hampshire is competitive with Northern New England states, this does not meet the New

Hampshire labor market demands for a higher standard of STEM preparation. The Task Force suggests that Group 6 identify strong STEM teacher preparation programs as models for New Hampshire including, for example, Massachusetts and Illinois.

- STEM specialists: Task Force recommends that there needs to be a clear description of a STEM specialist. Although similar to a Math specialist, the role of STEM specialists is not clearly understood.

- Professional Development: Badges or micro-credentials: the Task Force strongly supports professional development badges (or micro-credentialing) as an alternative pathway to building STEM K-12 teaching expertise and addressing the critical shortage of teachers in these fields. The candidate is being credentialed for accomplishing certain competencies as determined by the definition of the badge.

- For teachers in STEM subjects, a defined number of badges, once attained, would qualify a teacher to become a STEM specialist. Midcareer and retired STEM professionals who are candidates in an alternative certification program would be able to earn badges for competency in teaching/pedagogy. TF suggests defining "alternative certification" for readers who are not familiar with this term.
  In addition, the Task Force suggests that STEM badges eligible for additional remuneration.

Group 8: Next Generation Science Standards. Lead author: Dr. Brian Blake
No changes recommended

c. Discuss STEM definitions (See Addendum C)

Robert Hallowell agreed to draft the next phase of the STEM definition. He was provided with background documents from national sources.

d. Review "parking lot" ideas and determine next steps (See Addendum D)

Discussion was deferred until next meeting.

e. Recommendations for Post-Task Force leadership on STEM K-12 will be led by Dr. Ross Gittell and Barbara Couch.

f. A revised copy of the final report outline and revised timeline was distributed (See Addendum E)

IV. Public input (if members of public are present):

Policy for speaking (2 minute limit) and invitation to submit written remarks. Mr. Laliberte thanked the Task Force for its work and urged them to make teacher STEM professional development a priority because properly trained teachers are the starting point for a STEM-ready workforce.
Mary Laturnau noted that since the Task Force had been discussing how to bring more young women into STEM studies, she thought it useful to give them a list of relevant programs in New Hampshire to be added as part of the public record.

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ADDENDUM A

Outline for Final Report to the Governor (10.9.14)

I. Executive Summary (1-2pp)

This summary will include the meta-theme(s) that will organize the big ideas contained in recommendations, the list of recommendations, and appropriate infographic representation. *Note: the executive summary will be the most widely read portion of the report so we will strive to make it concise, clear and informative.*

II. Introduction (1 -2 pp)

- Setting the Stage: Why STEM and why STEM now? The case for economic and education to workforce realignment (the dwindling pipeline for STEM after 6th grades)
- Governor's Executive Order, the charge to the committee, etc.
- Explain what is to follow – provide visuals? Call outs?

III. STEM Education: NH Context (2 pp)

- Defining STEM, STEM education and STEM careers (we have noted that there is no consensus nationally on what these terms mean and therefore we need to clarify for our readers).
- NH STEM: Needs and vision for the future
- Learning skills or descriptor (define and link to STEM) 9.25.14 added –pull in key educational requirements like learning skills into the STEM plan. How do these things all fit together? How to we make this a coordinated effort?
- The items above might be combined in a paragraph or shown visually.

IV. Recommendations in Detail

- Each recommendation described – uniform format 2 pages each)

V. **Next Steps:**

- Resources needed (address resources needed for recommendations, rather than in each recommendation). Added at the 9.25.14 meting
- Implementation: overarching/global things to do –such as formalize a continuing leadership group to follow through on STEM recommendations and action plan. To oversee and provide accountability to the NH public. Suggest groups. Draw from the STEM work by the New Hampshire Chartiable Foundation Report and the preivous Coalition for Business and Education . Others?
- Commitments and actions required (2 pages
    - For Educational leaders in NH (added at the 9.25.14 meeting–specify who we mean) In particular: school boards, principals, superintendents, teachers, parents, etc.
    - For Policymakers in NH(suggest hearings to hold? Legislation to pass?

- For Business and Industry Leaders in NH (e.g. Business should find support for teacher prof development badges costs, provide internships, externships, etc)

VI. Conclusion (1 Page)

- If applicable, perhaps put in a summary grid of recommendations to recap report

VII. Endnotes

VIII. Appendices

- Task Force members
- Task Force: How it was organized and executed (subcommittees, etc.)
- Resource readers

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ADDENDUM B – OCT 7, 2014 VERSIONS OF RECOMMENDATIONS 1,3,4,6,8 TO FOLLOW

STEM-INSPIRATION:

Group 1: Building Student Interest in STEM through Challenges, Competitions, and Capstones

Problem Statement

Studies show that students gradually disengage from science and math in the later years of elementary school. Their natural curiosity about the world is replaced by a perception that science is difficult, or is only for a certain type of student. A major challenge in developing a STEM-literate population and skilled workforce therefore lies in maintaining excitement through the critical middle and high school years, to keep students engaged in learning. Students need to understand that science and math provide a foundation for understanding the world, and be inspired to apply that understanding to invent solutions to some of the world's most challenging problems through engineering and the development of technology.

Recommendation

Applied STEM learning opportunities, including competitions and capstone projects, should be expanded, and incorporated into school curricula at several levels, using FIRST as a base and model program. At a minimum, age-appropriate STEM-INSPIRATION sequencing should begin with thematic, project -based STEM topics or "challenges" in early grades, then move to collaborative, team-based district-wide or regional STEM competitions in middle school, and finally to a capstone project which requires independent problem-based project research, and presentation of results for peer and evaluator review in high school. NGSS (adopted by many districts in NH) is closely aligned and integrated into this work.

Recommendation Details

Baseline:

Utilizing the NGSS as a foundation piece, each SAU will design and implement a sequence of performance assessments at each grade level beginning at grade 4.

Utilizing the NGSS as a foundation piece, each SAU will develop a thematic, project-based exploration of a relevant STEM topic in elementary school, ideally in 4th grade. This "challenge" would be a broad theme or question around which a teacher can provide context and insight, students can read and discuss stories on the topic, and an age-appropriate in-class or at-home project would be developed. SAUs and individual schools are particularly encouraged to consider focusing on the "T and E" elements of STEM in designing the challenge. Schools may, for example, draw upon the curriculum outlined in the "Engineering is Elementary (EiE) program.

Competition: To provide opportunity for deeper learning, each middle school will field at least one team participating in an organized STEM-related competition. FIRST Lego League and FIRST Tech Challenge are NH-based examples of such competitions.

Utilizing the NGSS as a foundation piece, each high school will design a "Capstone" experience that will require each student to conduct independent problem-based project research in a STEM area, either individually or as part of a group effort, and present the results for peer and evaluator review. As a "capstone," it is expected that each project will address an open-ended question or hypothesis, and build on material from a range of high school courses. It is strongly recommended that such capstone projects go beyond paper studies to incorporate a laboratory, computational, field-study, or technology or engineering component.

Each SAU will incorporate specific technology/engineering based activities and performance assessments at each grade level, in alignment with the NGSS.

Advanced:

For deeper engagement with STEM content, methodologies, and opportunities, schools may wish to build beyond this foundational level. For these schools, the following are recommended:

A capstone project will be included in the final year of middle school for each student

Participation in a team-based, district-wide or regional STEM competition such as FIRST Robotics will be supported at the high school level.

Target Audience and Measures of Success

The goal of this recommendation is to build a process for students to become STEM literate at different levels, from "aware and conversant" and able to adapt to changing technology in the workplace, regardless of chosen career, to highly trained scientists and engineers leading the discoveries and inventing the technologies of tomorrow.

Once fully implemented, the targeted levels of participation at the baseline level are as follows:

All NH elementary school students will participate in a thematic STEM challenge.

All NH middle schools will participate in a STEM competition such as FIRST Lego League or FIRST Tech Challenge.

All NH graduating high school seniors will complete a STEM-focused capstone project.

Implementation Plan: Necessary Steps and Resources

School districts will need curricular support for elementary teachers to develop examples of STEM-based challenges.

Funding will be needed to help support middle school participation in STEM-based competitions such as FIRST

Local volunteer coaches will be needed to help support middle school participation in STEM-based competitions such as FIRST.

A committee of high school science and math teachers and other parties as appropriate will need to develop curricular guidelines for high school STEM capstone projects

Additional

[Girls remain significantly underrepresented in many STEM fields. This is particularly true of engineering and computer science, where fewer than 20% of bachelor's degrees are awarded to women, a number that has changed little in decades. In some branches of engineering however, particularly those related to the life sciences, the percentage of women is much greater and in some areas approaches gender parity.]

Competitions such as those sponsored by FIRST excite and inspire young students to experience and explore STEM and develop their creative talents. FIRST explores broad themes and is collaborative and team-based, but the underlying elements of mechanics, robotics, and coding do not appeal to all students. The challenge is to develop a comparable "collaborative competition" for students in grades 6-8 or 9-12 that appeals to those students who may not be drawn to competitions in robotics and related areas. Development of o ne that draws directly from the life sciences, medicine, and related fields may help address this need.

Benchmarks

Identify states with highest percentage of schools or school districts participating in FIRST or other STEM-based competitions. Using this as a goal, set timeline for NH to attain a position of national leadership.

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ADDUMDUM B (CONTINUED)

STEM Innovation Hubs: GROUP 3

Creating an engine for improving teaching, delivery and support

Problem Statement:

The need for collaboration between schools, businesses, student and parents in terms of creating STEM curriculum and activities is critical to the successful implementation of STEM development in the schools, in the workplaces and in the home. Yet, these interactions are only sporadically supported and are usually implemented as part of one-time conferences, or by individual districts partnering with individual companies, or by a motivated teacher and parent collaborating on a presentation. These sparse and uncoordinated exchanges often result in good ideas but limited impact on the overall student population, and typically with little or no feedback as to efficacy.

RECOMMENDATION:

The Task Force believes that the state should support collaboration spaces where groups of STEM professional can work in partnership with K-12 teachers. These "STEM Innovation Hubs" would become regional centers where businesses could explain the skills that are lacking in job seekers and teachers could describe the challenges they have in teaching STEM competencies. Together they would formulate strategies to teach and inspire students in STEM using the best practices in education and the real world examples of STEM businesses. Businesses would have a voice in relaying the STEM skills needed in the workplace, and in turn teachers would gain relevant knowledge in how and why these STEM skills are needed and applied.

DETAILS

STEM Innovation Hubs would provide businesses and teachers a regional environment for engaging in discussions on what students need to know and what are the techniques best used to teach them how to do it. The scope and makeup of these hubs would include but not be limited to the following:

- **Location**: Somewhere between 5 and 15 regional centers would be supported with the number being governed by the need to make the centers readily accessible to the population of businesses, school and

students that they will serve. The centers would serve as a physical location for STEM activities including virtual and in –person courses, seminars, discussion groups, and STEM demonstrations and experiences. *Note: There are a number of facilities that might be adapted for this use including: (1) the network of LECSN (Local Education Center Support Network), a series of five centers throughout NH that provide teacher professional development and technology support; (2) Science museums such as a Montshire (Upper Valley); The McAuliffe-Shepard Discovery Center; The UNH Discovery Lab, and others; and (3) the STEM-infused CTE programs described under the "Stem Centers of Excellence" recommendation.*

- **Staff Resources**: School districts within each region would provide at least one STEM teacher as a representative to the STEM center. Local businesses with STEM-related expertise and/or businesses would also provide at least one STEM professional as a representative to the STEM center. Others may also be invited to participate on specific projects and/or discussions.

- Services:
    - Regular meetings of the coordinating committee to explore STEM curriculum and discuss new thoughts in science, technology and engineering.
    - Provide in-person and on-line areas for STEM activities by the local community (this could include areas such as Makespaces and Fablabs). These activities would include parents and students.
    - Provide collaboration space to explore specific STEM gaps and needs. The goal of these efforts would be to clearly define the gap and provide teaching solutions (curriculum delivery, exercises, and/or demonstrations) for filling the gap.
    - Could also provide a "lending library" for STEM curriculum materials not available in local schools or districts (for example the MobileLabs and STEM packs discussed in the "STEM Everyday" recommendation.)

ADDENDEUM B (CONTINUED)

<u>Look, touch and feel STEM Every Day: Integrating STEM in the Classroom</u>: GROUP 4

"Science and math are about understanding and interpreting, while Technology and Engineering are about invention, creation, and the development of solutions to challenging real-world problems".

K-8 students should be taught the basic concepts of math and science but also exposed to hands-on learning of those base skills as they apply to technology, engineering and the wide breadth of STEM topic areas.

Merged Problem Statement:

In-school opportunities for STEM related learning is insufficient, particularly in K-8, for a variety of reasons: (1) science time has been eliminated or reduced to focus on core subjects of reading, writing and math (2) even when science is included it does not encompass the application of math and science for technology and engineering (3) without science, technology and engineering students have little opportunity to apply their math skills (4) teachers lack the training and experience to create and deliver in an engaging way STEM instruction and hands-on learning (5) students are left with little opportunity to explore STEM topics that might interest them and create a passion for learning. The TF recognizes that a strong foundation in math and science is necessary but not sufficient for students to excel in Technology and Engineering. Our recommendation here is meant to "elevate our game" in STEM across the state, and not simply check off the science box as STEM.

RECOMMENDATION:

Support the "day to day" application of science and math in K-8 education with hands-on learning of those base skills as they apply to technology, engineering and the wide breadth of STEM topic areas. Goal should be applied STEM every day in different ways for young NH learners. Technology and engineering are the "TiE" that makes STEM relevant and exciting particularly for students who learn by doing and experiencing rather than by reading and memorization. This recommendation attempts to address three key barriers to STEM education -- the tightly packed K-8 schedule, the shortage of quality applied STEM resources, and the lack of current and applied science expertise among teachers in K-8 grades.

DETAILS

There are two core resource areas that we are recommending as ways to extend the state's reach to the core of STEM – Technology and Engineering. These areas are (a) physical and schedule space, (b) the availability of STEM units and resources and (c) external subject matter experts for the classroom

Physical and Schedule Space:

Creating space and opportunity for exploration is critical for engaging students in building, innovating and experimenting. The task force recommends the following infrastructure improvement be implemented by the state:

STEM Labs/ "Maker-spaces":

The state should support the creation of STEM labs in not only middle school but also elementary. A STEM lab differs from a science lab in that there are areas of the lab where students are allowed to explore and build on their own. A bin of LEGO robotics, or electronics that can be dismantled and reassembled might be appropriate at the middle level. While at the elementary level simpler materials for building (blocks, legos, weather experiments, etc.) would also work. There are many examples of such spaces being built and utilized across the country, a set of components would be defined by the state and local districts could pick and choose the components they would like to use. The state would subsidize a portion or all of the expenses for the equipment for the SAU.

Most middle schools have existing science labs that could be converted to STEM labs. At the elementary level, some schools would have space to create a STEM lab while others might be able to convert a portion of their library space into a STEM lab.

Making time for STEM:

Having physical space for students to explore STEM is only useful to the extent that schools can make time for STEM in the daily schedule. Most middle schools already have a period for science; we would propose renaming those classes and incorporating technology and engineering into a new STEM period. In addition, the STEM lab could be used by other subjects (math, English, music, art, PE) for periodic integrated sessions that explore the relationship between STEM and the particular subject.

Elementary schools have a more challenging schedule. Ideally, a regular time slot for STEM instruction would be ideal (combined with math perhaps). Alternatively, however, STEM could be integrated in the specialist (art, music, PE, etc.) rotation to provide weekly instruction.

STEM Units and Resources:

While some districts will have the funds and staff to create their own unique STEM curriculum resources for many rural districts this will be a challenge. In addition, there are sometimes advantages to having collective access to STEM technology that might be challenging for any single district to justify. Therefore we recommend the state support the development of the following state-wide resources:

Pre-packaged STEM packs:

STEM packs contain a single experiment and a unit of instruction as a guide for the teacher. For example the pack might contain the parts to make a weather station that the student must learn to assemble. The unit of instruction would show the teacher how the weather instrument works and how to show students what they might do with it.

Mobile STEM Experiences:

The state would maintain a fleet of mobile labs for school districts to bring in as a special STEM experience. Some examples might be: a blow-up planetarium, a large telescope, small radar, a solar array, a wind turbine, etc. Local districts could use these for specific classes or as part of a community experience (for example an "astronomy" night where community members bring their own telescopes in addition to the large telescope or planetarium).

STEM Program and Online Resources:

The state would create supports for established STEM programs such as Project Lead The Way (gateway, Launch, etc.) for grades K-12. In addition, the state would support the integration of STEM online and video resources such as Discovery Streaming, PBS Learning Media that have already been successfully piloted in other districts. The support from the state may include direct subsidies to districts that implemented these resources but also the ability to negotiate reduced pricing based on volume.

External Subject Matter Experts:

STEM Explorers:

Create a STEM EXplorers bureau (STEM-EX) where STEM professionals in industry and at colleges and universities in NH would make themselves available as resources for project based learning, in class presentations/demonstrations and/or "site visits" to local schools. Explorers would have to commit to registering with their areas of expertise and contact information and to being available at least twice during the school year.

The Explorers would be recruited with a variety of backgrounds and from a variety of STEM fields in SAUs across the state. The Governor would put out a call for volunteers and higher education institutions (including the CCSNH, USNH, SNHU and other NH based colleges) and industry groups (including the High Technology Council, NH Business and Education Coalition and the NH Business and Industry Association would recruit Explorers. One of the educational institutions (e.g., UNH Education Department) would take the lead with recruiting, screening registering, training and organizing the Explorers with support from a state or Foundation grant.

An online "directory" of NH STEM Explorers would be created. It would have information and key word/capability search capabilities on location, subject matter expertise, grade level preference, and activities of

interest among the fields of information available for each Explorer. There would also be capabilities for feedback and recommendations from teachers and students to Explorers and from Explorers to teachers. And there would be summary ratings/comments available as reference for other Explorers and Teachers to access.

At the end of each academic year Explorers who have successfully assisted STEM education in NH would receive formal recognition from the local SAU and Governor and also be eligible for annual award of STEM Explorer of the Year.

STEM Adventurers:

As above, create a resource database of businesses or higher education institutions that would provide field trips and learning experiences for students. The Governor would put out a call to NH Businesses and higher education to create such opportunities. Prospective businesses/colleges would identify the STEM focus of their activities and the age level of the experience. As with the STEM-EX, businesses who provided opportunities to students would be recognized for their efforts and be eligible for an annual adventurer award. These adventures would include field trips, internships, weekend events, summer experiences, etc.

STEM Leadership Ambassadors (STEM Diplomats): Loan of business and academic leaders in STEM fields for a period of one-year to be known as the "STEM Ambassadors" to act as liaisons on STEM to parental groups such as PTOs, to professional organizations such as NH Teachers of Mathematics, Business and Industry Council, district school boards, charter school boards and to Education, testify and meet with appropriate committees in the NH House and Senate.

Benchmarks:

There are obvious benchmarks such as NECAP science scores, and SBA math scores. But are there leading indicators?

- The number of schools with transformed STEM labs
- The number of students who opt for science or other STEM electives in high school

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Creating and Supporting STEM Qualified Teachers GROUP 6

Recommendation: Ensure that all teachers, especially K-6, have the knowledge, skills and pedagogy needed to help all New Hampshire students successfully complete a STEM-embedded curriculum.

New Hampshire teachers are constantly adjusting to increasing demands: modifying their pedagogical approaches to meet children's needs for new and heightened curriculum requirements such as the Common Core State Standards and, if adopted, the Next Generation Science Standards; incorporating instructional and assessment techniques based on recently uncovered understandings of brain development; and deepening their own content knowledge to address reforms such as the integration of STEM and 21st Century Skills into daily learning experiences.

For New Hampshire to sustain the generation and development of high-quality highly-skilled educators, improvement is still needed in elementary teacher preparation and overall professional learning opportunities, especially in grades K-6.[1] In essence, many of our teachers lack the training and experience to create and deliver STEM instruction and hands-on learning in an engaging way:

> *If K-12 student interest and performance in mathematics and science is "solidly linked to teacher excellence," then we must provide the best possible opportunities for the development of a highly skilled workforce of teachers of mathematics and science.*[2]

Supports will be necessary in order to achieve the outcomes of the accompanying STEM Task Force recommendations. We must build upon the existing teacher preparation programs in New Hampshire colleges and universities. Likewise, the New Hampshire Department of Education, teacher education associations, school administrators and even industry must support and provide meaningful and enduring professional learning opportunities in STEM content for teachers already in our classrooms.

Recommendation Overview -

In order to both generate and develop NH STEM teachers, we propose a two-pronged approach: (1) New Hampshire colleges and universities with teacher-preparation programs institute common post-secondary mathematics and science requirements, especially for elementary pre-service teachers, and integrate meaningful practicum and externship experiences into their teacher preparation programs, and (2) teacher professional development be redesigned to provide incentives for teachers to earn micro-credentials and badges in STEM content and pedagogy.

[1] The National Council on Teacher Quality's 2014 Teacher Prep Review

[2] Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future (2005)

Teacher Preparation

> *Preparation institutions must determine if the depth of math and science content in their programs is sufficient to support teacher candidates in achieving new licensure requirements, and if data-based decision making and inquiry-based instructional methods are appropriately incorporated into the candidate experience.*[3]

Fortunately, New Hampshire is already addressing the former through the incorporation of the Institution of Higher Education Network, NH IHE[4].

> *The New Hampshire IHE Network was created with the primary aim of working collegially to influence policy makers and engage practitioners to promote innovative programs and policies that link initial educator preparation, new educator induction, and ongoing professional development in New Hampshire.*

This group of teacher preparation institutions can work to create a solid, STEM-infused elementary program, without diminishing the attention given toward reading, writing, and special needs. The collection of research that connects teacher knowledge of content and pedagogy is vast, and now is the time for these systems to be in place in order for our preserve teachers to *experience as students* the type of classroom climate that is expected of them *as teachers.*

While this is not to say that teacher candidates must major in a STEM field, elementary candidates who do not should have significant content background with mathematics and a variety of sciences so they can knowledgeably integrate STEM into every day.

Professional Development

As New Hampshire educates a new generation of elementary-certified teachers, our own Department of Education, Teacher Education Associations, School
Administrators and Industry Leaders must collaborate to provide a variety of incentivized professional learning opportunities for teachers already practicing in the K-6 classroom. These teachers are ***pivotal*** to the success of the STEM initiative, and must be recognized for their achievements in promoting STEM in their classrooms, in their schools, and in their districts.

Classroom teachers need a variety of opportunities to seek professional development in STEM. This could include (but is not limited to) summer course work and symposia, sabbatical/externships/field experiences[5],

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[3] NH Charitable Foundation Report, Education First, NH STEM Pipeline 2013

[4] http://education.nh.gov/spotlight/ihe/documents/ihe-initiatives.pdf

[5] NASA Innovations in Climate Education, STEM Teachers Academy, EnCorps STEM Teachers Program, and the Boston Museum of Science Professional Development Center are dynamic, exemplary repositories of STEM experiences that invite

weekly involvement in professional learning communities (during or after school), becoming a STEM Specialist, or intensive teacher research[6].

Places such as University of New Hampshire's Leitzel Center and STEM Discovery Lab can provide multi-faceted experiences for both pre-service and in-service teachers to engage and practice hands-on, real-world integration of STEM and language arts through a research-based series of learning activities. These scalable and sustainable collaboratives bring together students, teachers, and academia in a learning community: benefitting all three constituent groups at once.

Benchmarks

- Increase math and science content requirements for elementary (K-6) teacher prep programs and certification.

  Action Needed:

  Identify requisite knowledge[7] needed for a substantive background in math and science, defined in terms of specific learning outcomes (Teacher candidate will know and be able to do…)

  Determine number of credit hours in mathematics and science/inquiry should be required (at minimum) for certification

  Report annual achievements with respect to number of students graduating from the baccalaureate programs and graduate education programs meeting these new requirements; those gaining employment in NH schools; and determine effects on student performance in mathematics and science once these teachers are employed

  NH DOE raises minimum score requirements on math and science subtests of the Praxis, for Elementary Teacher Certification, correlating to the increased demand in those content areas

  Actors: NH IHE, NHTM, NHSTA, NHSTE, NHTEA

  Timeline: Fall 2015; Reports ongoing starting January 1, 2016

- Identify exemplary teacher practicum sites, such as what could be provided by programs like the UNH STEM Discovery Lab, the UNH Leitzel Center, or STEM Externships offered by Cooperative Extension or local industry.

  Actions Needed:

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educators to learn more about the inquiry process and raising awareness of STEM career fields. Several of these programs also invite professionals already in STEM fields, and even the military, to become educators.

[6] http://www.naeyc.org/files/naeyc/file/vop/Voices-Stremmel(1).pdf

[7] Common Core Math State Standards and Next Generation Science Standards

NH DOE, Institutions of Higher Education, and the Legislature commit to support and fund the scaling up of programs congruous to the UNH STEM Discovery Lab to be housed at the LESCN Regional Professional Development Centers. Centers to open across the State by September 2016.

NH DOE determines measures of excellence (rubric) for programs/experiences that provide hands-on, integrated, inquiry approach in STEM teaching. Each program will be evaluated based on DOE rubric by attendees, and receive "STEM Stars" to indicate their reviews. Programs meeting the rubric standards would be partially funded through legislation, grants, and local business and industry.

Business/industry and science labs commit to provide STEM Externships for teachers. "Leadership 100" Programs - which promise of 100 externships by the end of 2015. (such as Project Lead the Way, EBD, NHEET, etc.); also to be evaluated by NH DOE rubric, and partially funded through legislation.

Actors: NH DOE, Business/Industry and Science Labs, Legislature

Timeline: January 1, 2016

- Expand graduate certificate programs in education to include certificates in STEM[8]; and offer micro-credentials for technology, biology, ecology, physical sciences, mathematics, engineering principles, etc., which can also be awarded to career and ex-military workers seeking alternate certification. Any teachers can earn badges[9] to show they have a background in one or more of the STEM fields, and have received additional training to teach STEM as an integrated subject. Teachers would receive additional pay for these micro-credentials similar to what is offered for post-bacheloriate study.

  Actions needed:

  Badges would be defined and named by NGSS topics and CCSS domains: Ex., Life Sciences, Physical Sciences, Earth and Space Sciences, Operations & Algebraic Thinking, Ratios and Proportional Relationships, etc., would be made available to educators after meeting research-based pedagogical expectations within that strand (TBD by DOE)

  School systems will provide monetary remuneration equivalent to what is offered for credits of post-baccalaureate study, with the caveat that micro credentials do not have to be compiled into larger categories in order to be rewarded. (no need for B+10 or B+15 credits. One badge = $x)

  NH Legislature will pass legislation that awards districts for having 25%, 50%, and 75% of their Elementary teachers earn at least five of these badges. (meeting larger benchmark = greater "reimbursement")

  Actors: NH DOE Bureau of Credentialing need to approve Badges, and

  School Administrative Units need to fund the remuneration for micro-credentials; Graduate Education Programs offer STEM Certificates

[8] http://christa.org/stem-certificate-program/; http://www.us-satellite.net/endeavor/about-certificate.cfm; https://www.cambridgecollege.edu/degree/stem-certificate-science-technology-engineering-and-mathematics; http://education.jhu.edu/Academics/certificates/stem

[9] http://www.digitalpromise.org/blog/entry/micro-credentials-empowering-lifelong-learners

Timeline: Beginning July 2015, NH DOE sets forth requirements for Badges; Graduate Education Programs define and offer STEM Certificates Fall 2015

- Utilize Mathematics Coaches/Specialists in every K-6 or otherwise defined primary/elementary school.[10] Coaches or Specialists "would work with teachers in and out of the classroom to co-plan and co-teach lessons, and then reflect on the lessons afterward. They would share best practice research through professional learning opportunities, monitor mathematics program implementation, oversee curriculum and instructional resources, and inform mathematics instruction using student work, assessment data and benchmark tests."(Ibid) Districts could expand on the Math Specialist position to create a STEM Specialist, provided they meet minimum criteria for and Elementary Mathematics Specialist and at least two of the science topics, as defined in NGSS.

  Actions needed:

  Identify 5 pilot districts that already have STEM or Math Specialists built into their framework to join a consortium whose job is to develop a model structure for the implementation of coaches/specialists. This model will be based on current research of best practice such as described by the NH Mathematics Task Force and NCSM.[11]

  Pilot districts enact their model with "open classroom" for other districts to observe and learn from (September 2015).

  School districts assume responsibility for observing model coaching structure as defined by consortium, and implementing no later than September 2018.

  Actors: Districts to form Coaching Consortium for model

  Timeline: Pilot districts identified by February 1, 2015. Consortium to meet and research current coach/specialist practices, and create a model framework for districts. Pilot districts open their schools for review of coaching practices September 2015. Twenty schools by January 2016, 50 schools by January 2017, all elementary schools utilizing coaching/specialists by September 2018.

[10] It's Time: Themes and Imperatives for Mathematics Education, NCSM p.52 (2014)

[11] http://www.mathspecialists.org/NCSMSmr-Fall11JournalFennell.pdf

ADDEUNDUM B (continued)

Task Force on STEM Education Group 8 (version 10.7.14)

Next Generation Science Standards integrating Engineering & Technology

Problem statement

The current Science Standards for New Hampshire were adopted in 2006, and are out of date. Since that time, many advances have occurred in the fields of science and science education, as well as in the innovation-driven economy. Advances in quantum mechanics, Next Generation Genomics, Synthetic Biology, Exome Sequencing/Rare Disease Genes, Molecular Dynamics Simulations, RNA Reprogramming, and Precision Cosmology, to name a few, will lead to exciting new applications and fields of study. Meanwhile, New Hampshire has a leaky K-12 STEM talent pipeline, with too few students entering STEM majors and careers at every level. We need new science standards that stimulate and build interest in STEM. They (current standards) do not address the full range of college and career ready 21st century skills, nor are they organized in such a way as to promote deep application of science principles, practices, or processes nor do they connect easily to other STEM areas, like engineering and technology. They focus primarily on information transfer, or recalling facts and do not lend themselves to student discovery and a deeper depth of knowledge. Additionally, the current standards are content specific and thus do not translate easily to the larger world, where cross disciplinary problems and necessary solutions are not just common place, but necessary for college and career readiness. Implementing improved K—12 science standards will better prepare high school graduates for the rigors of college and careers. In turn, NH employers will be able to hire workers with strong science-based skills—including specific content areas AND also skills such as critical thinking and inquiry-based problem solving.

Across New England, other New England Common Assessment Program (NECAP) states, (Rhode Island, Vermont, and Maine), have all adopted the Next Generation Science Standards. A Consortium decision has been made to administer the current science assessment for one more year, then the other states will be seeking a science assessment consistent with the new standards. New Hampshire, as a small state, does not have the resources to generate a large scale state assessment in science without significant support or as part of a consortium with other states.

Target Audience:

Standards are primarily used to guide curriculum development and instruction, as well as assessment design. The target audience will be K-16 educators in the state, as they go about the work of creating curriculum and assessments. K-12 students enrolled in public schools will be the recipients of these new products.

Desired goals and outcomes:

The NGSS incorporates practices, cross cutting concepts and key ideas including Science, Math and Language Arts. The Standards are written as performance expectations which require students to analyze, argue, construct, design, and develop (all 21st century skills). These cross-cutting concepts reflect the practices and thinking that transfer to other studies and disciplines. New standards have been developed that integrate three dimensions,

disciplinary core ideas (content), scientific and engineering practices, and cross-cutting concepts. The current state standards in New Hampshire express these dimensions as separate entities, leading to their separation in both instruction and assessment. The integration of rigorous content and application reflects how science is practiced in the real world. Science and engineering are also integrated into science education by the new standards, by raising engineering design to the same level as scientific inquiry in science classroom instruction at all levels, and by emphasizing the core ideas of engineering and technology.

Recommendations:

The Next Generation Science Standards (NGSS) were released on April 9, 2013 thus completing a two-step process for development through the partnership of the National Research Council (NRC), the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve. The first step of the process was led by The National Academies of Science, a non-governmental organization commissioned in 1863 to advise the nation on scientific and engineering issues. The National Research Council (NRC), the functional staffing arm of the National Academies of Science, developed the ***Framework for K-12 Science Education***. The *Framework* is grounded in the most current research on science and science learning and has identified the science all K–12 students should know.

In step-two, managed by Achieve, 27 states led the development of the NGSS which are designed to actively engage students in scientific and engineering practices by applying crosscutting concepts to deepen their understanding of the core ideas in science.

New Hampshire should undergo a process leading to the adoption of the Next Generation Science Standards (NGSS) to replace the current standards that were adopted in 2006. The NGSS shifts the focus to the instructional practices that create engaging, innovative classroom experiences. The NGSS is less about curriculum and more about instruction at the classroom level.

There is a need to prepare for a new assessment system that is consistent with current standards and science education pedagogy. Inquiry based science, inside and outside the classroom in instruction and assessment practices, will best prepare students for the challenges they will find in college and real world careers.

Success will look like:

All school districts in the State of NH will be utilizing the NGSS as key foundation documents for the development of new curriculum and instructional practices, leading to more rigorous and appropriate teaching of Science in NH schools.

Implementation plan

Because of the on-going concerns for ownership of educational practices by the NH community, it is recommended that the Governor:

- Designate a Leadership Team at the State level to further review the standards in depth and to lead the overall implementation.
- Recommend any additional expectations that are key to NH's success in science education and in concert with NH's robust scientific and engineering communities.
- Review the State's capacity for adoption and implementation, including the development of curriculum, instructional practices, and assessments.
- Create a concise timeline for adoption.
- Create STEM and NGSS Coordinator at State level
- Develop a vision for how the NGSS will affect students in NH.
- Determine what the financial requirements will be for implementation.

Challenges:

There are many New Hampshire stakeholders, at the state and local levels, in K-12, post-secondary, and in the business community that will need to be an integral part of the process and the outcome.

Timeline

It is expected that the process will take two years total to complete:

- Phase I (3 months)—
    - Designate a Leadership Team at the State level to further review the standards in depth and to lead the overall implementation.
    - Create STEM Coordinator at State level to lead the process
- Phase II (6 months)—
    - Review the standards and recommend any additional expectations that are key to NH's success in science education and in concert with NH's robust scientific and engineering communities.
    - Review the State's capacity for adoption and implementation, including the development of curriculum, instructional practices, and assessments.
    - Develop a vision for how the NGSS will affect students in NH.
- Phase III (6 months)--
    - Issue report of recommendations to the Governor, State Board of Education, and NH Legislature
    - Create a concise timeline for adoption.
    - Determine what the financial requirements will be for implementation.
- Phase IV (9 months)—
    - Develop materials to support implementation at the school level
    - Communicate with key stakeholders regarding standards, professional development, instructional practices, and assessments.
    - Select new assessment provider to align with new standards

Best practices:

Other New England States have adopted the NGSS and we would work with them toward successful implementation.

- Peter McLaren of the Rhode Island Department of Education was a key contributor to the development of the NGSS. Rhode Island was the first state to fully adopt the standards and has developed webinars, materials, and provided in-depth professional development for educators in the Nutmeg State.

- Massachusetts was a lead state partner in the development of the NGSS signing on in 2011. The review of the Massachusetts Science and Technology/Engineering (STE) Curriculum Framework started in spring, 2009, and is now anticipated to be completed SY 2015-16. At the October, 2013, MA Elementary Secondary Education State Board meeting the MA Department laid out the timeline for moving forward with revised Science and Technology/Engineering standards. The Department will make the draft revised standards public but will not be moving them forward to a public adoption process until the 2015-16 school years. The design process is based on the foundation of the National Research Council and the Next Generation Science Standards. Currently, MA Science, Technology, and Engineering Standards are organized by grade bands, including Pre-K–2, 3–5, and 6–8. High school courses are arranged by content in Biology, Earth and Space Science, Chemistry, Introductory Physics, and Technology/Engineering. Science is assessed through the Massachusetts Comprehensive Assessment System (MCAS) in grades 5, 8, and end of course assessments at the high school level. Since 2007 the state expects all students to pass one of these high school assessments to graduate. Massachusetts' current standards have been in place since 2001, and have been undergoing revision since 2009. This process was supposed to be complete in 2011; however Massachusetts decided to delay this process to match the projected timeline of NGSS development.

- The Next Generation Science Standards were approved by the Vermont State Board of Education in June 2013. These standards are now considered to be the foundation of all Vermont science instruction. School programs will gradually incorporate these standards into curricula and instruction. School year 2013-2014 is considered to be an Awareness time, wherein teachers will begin to become familiar with these new standards and will blend portions of these standards into their existing instruction. Professional development and instructional resources will be available through the Agency of Education and other sources.

ADDENDUM C – STEM DEFINTIONS

STEM DEFINTION DRAFT VERSION #1

K-12 STEM education is a disciplinary and interdisciplinary approach to learning, understanding, and engaging with science, technology, engineering, and mathematics in the classroom, business, industry, and life. The disciplinary approach supports student acquisition of depth in the fields of science, technology, engineering and math while the interdisciplinary approach supports agility in crossing traditional boundaries separating the academic disciplines. The dual approach fosters critical thinking, analysis, synthesis, collaboration, and innovation as students work to solve complex scientific, technological, engineering, applied mathematical, and related problems as they exist in the world. In doing so, K-12 STEM education serves the public good by promoting the development of skills and competencies that enable individuals to be successful in both STEM and non-STEM academic settings, extracurricular pursuits, and post-secondary plans that may include joining the workforce and pursuing higher education.

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

October 7, 2014

Manchester Community College, Manchester, NH

ADDUMDUM D: PARKING LOT: FOR IDEAS TO CONSIDER AND/OR INCLUDE IN FINAL RECOMMENDATIONS Draft August 13, 2014 – UPDATED OCT 7, 2014

1. Girls in STEM

2. Rural students (lacking easy access to resources)

3. Administrative structure to oversee implementation and accountability for STEM recommendations (annual reports?)

4. Home schooled students

5. STEM online courses such as Virtual Learning Academy Charter School (Exeter, NH)

6. Inclusion of international assessment standards in the mix (see Caroline's recommendation)

7. Inclusion of the Arts

8. Inclusion of professional school counselors and college admissions directors

9. Consider incentives to encourage STEM mastery for teachers

10. Include consideration of expectations of each group to be impacted and/or tasked with implementation of a taskforce STEM recommendation

11. Consider coordinator functions (those charged with implementing STEM recommendations) to ensure a cohesive set of responsibilities; consider separating oversight for Common Core English Language Arts/Math and science/Next Generation Science Standards

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

October 7, 2014

Manchester Community College, Manchester, NH

ADDENDUM E: REVISED TASK FORCE TIMELINE FOR PREPARATION OF FINAL REPORT

Governor's Task Force on K-12 STEM Education

Timeline and Meeting Schedule

October 7	Review revised recommendations. Review and discussion of report outline (distributed prior to meeting); additional writing assignments (volunteer)
October 21	Final review of recommendations, STEM definition and other report content.
October 28	Meeting with Governor, review recommendations

Via email and conference calls…. report draft reviewed and revisions suggested

October 30	Optional: reserved in case above schedule is delayed or additional review needed
November 4	Final report reviewed and approved
November 10	Reserved if needed for unexpected delays
November 14	Report is submitted to the Governor

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

October 7, 2014

Manchester Community College, Manchester, NH

ADDENDUM F: GIRLS IN STEM ACTIVITIES AND PROGRAMS Provided by Mary Laturnau, *Director of School Engagement*, ME, NH, VT, Project Lead The Way, Inc.

***FIRST* Women in Science and Technology Forum for High School Girls**

Where: *FIRST* Place and UNH Manchester, NH
When: November 7, 2014
Sponsor: NH Space Grant Consortium
High School girls
For more information contact: ksullivan@usfirst.org

Expanding Your Horizons
Exeter Women's Club
http://www.eagfwc.org/Expanding_Your_Horizons.html
May 9, 2015
6th to 8th grade girls
Cooperative MS, Stratham, NH

Girls Technology Day
2015 dates : March 18th – NHTI, March 19th MCC
Manchester Community College and NHIT-Concords Community College
Contact: MCC- Kate Guerdat (kguerdat@ccsnh.edu) and NHTI-Chuck Lloyd (clloyd@ccsnh.edu)
No website at this time.

WIST- Women in Science and Technology http://www.ngcproject.org/program/women-science-and-technology-wist Facebook page: https://www.facebook.com/NHWomeninScienceandTechnology

Girls Inc. of NH After-School activities http://www.girlsincnewhampshire.org/

Engineeristas- UNH Academic Enrichment Camp
Grades 6 & 7
http://www.unh.edu/youth-programs/programs/summer?field_program_category_tid=124
http://nhepscor.org/stem/2014/engineeristas-girls-engineering

Aspirations in Computing
Yearly computer competition for girls in NH
http://www.ncwit.org/
http://manchester.unh.edu/blog/campus-news/aspiration-computing-event-encourages-girls-it

also:
Technovation Challenge at www.technovationchallenge.org

White Mountains Community College
Summer camps and Women in Science and Technology conferences
http://www.wmcc.edu/workforce-development/stem-activities

CCSNH camp listing from 2014
http://www.ccsnh.edu/news/community-college-summer-camps-introduce-careers-health-advanced-manufacturing-hospitality

Out of State:
Women Can Do
Girls grades 9-12
Sponsored by the Vermont Works for Women. Held in Randolph, VT.
http://vtworksforwomen.org/womencando/