NH K-12 MODEL SCIENCE COMPETENCIES
April 24, 2014

In May 2013, the New Hampshire Department of Education invited educators to participate in the process of creating statewide college and career ready science competencies. These college and career ready science competencies will be added to the body of state college and career ready competencies for statewide use which currently include the New Hampshire Board of Education approved Common Core State Standards Aligned Competencies in Mathematics and English Language Arts (http://www.education.nh.gov/competencies/).

This invitation to New Hampshire educators was very well received. Forty-six educators expressed an interest in participating in this process. From those educators who expressed an interest, twenty-two educators representing the K-16 education spectrum were chosen for this work based on education level served, geographical representation, central office representation, and classroom educators. In addition to these educators, representatives from the New Hampshire Science Teachers Association and several nonprofit science organizations were also invited to serve on this design committee.

Rose Colby, Competency Consultant to the New Hampshire Department of Education, coordinated the project with Karin Hess and Jeri Thompson of the National Center for the Improvement of Educational Assessment facilitating the design sessions. The Center for Collaborative Education also participated in the process along with members of the New Hampshire Department of Education. The working group met on August 15 and August 16 and again on December 2, 2013.

NH K-12 Standards Aligned Science Competency Work Group:

David Pabst - Allenstown
DeAna Irving - Merrimack Valley High School
Deb Maloney - NH Science Teachers Association (NHSTA)
Deb O'Connor - Pinkerton Academy
Delese Hovey - Nashua School District
Fran Meffen - Dover School District
Heidi Orestis - Sanborn Regional School District
Jennifer Seusing - Nashua School District
Katherine McCandless -Kearsarge Regional School District
Leslie Houghton - Lisbon Regional School District
Melissa Goulet - Londonderry School District
Niki McGettigan - ConVal School District
Sarah Sallade - Sanborn Regional School District

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Steve Roberts - Inter-Lakes School District; NHSTA President

Amy Liptak - NH Technical Institute
Debra Dunlop - New England College
John Slater - Southern NH University
Libby McCann - Antioch University
Mark Turski - Plymouth State University

Jeri Thompson - National Center for the Improvement of Educational Assessment
Jiffi Rainie - NH Dept of Education
Judy Silverberg - NH Project Learning Tree
Karin Hess - National Center for the Improvement of Educational Assessment
Laurie Gagnon - Center for Collaborative Education
Marilyn Wyzga - NH Fish and Game; Children in Nature and Wildlife Educator
Rose Colby - Consultant, NH Dept of Education
Saundra Kent - Consultant, NH Dept of Education
Scott Marion - National Center for the Improvement of Educational Assessment
Stan Freeda - NH Dept of Education
Susan Cox - US Forest Service; Environmental and Conservation Educator

The goal of this work is to design a set of science competencies drawn from the best available standards using in-state and national models. These new science competencies will be used by the New Hampshire Performance Assessment Network in developing valid and reliable performance assessments to build and measure mastery of competencies in our local and state student assessment systems. Once developed, this system will include: (1) a set of common performance assessments that have high technical quality in the core academic subjects; (2) locally designed assessments with guidelines for ensuring high technical quality; (3) regional scoring and task validation sessions and local district peer review audits to ensure sound accountability systems and high inter-rater reliability; (4) a web-based bank of local and common performance assessments; (5) and a network of QPA Distinguished Educators to support districts and schools.

State and National Standards Models

In June 2006, the New Hampshire Frameworks for Science Literacy K – 12 were approved by the New Hampshire State Board of Education. This Framework includes Grade Span Expectations (GSE's) that clearly delineates expected science content for two or three-year grade spans upon which New England Science Assessment Program (NECAP) is based.   These developmentally appropriate science targets found in the New Hampshire Frameworks for Science (2006) will continue to be the basis for the NECAP assessment program.

It is important to know that the New Hampshire Frameworks for Science Literacy K-12 were originally based on the National Education Standards commissioned by the National Research Council (1996).

 In 2012-13, two important National Standards documents were published. The National Academies of Science published *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* This Framework draws upon earlier foundational documents in science education: *Science for All Americans* and *Benchmarks for Science Literacy* as well as the National Education Standards of 2006.

The Next Generation Science Standards (NGSS) were written in partnership with the National Research Council, The National Science Teachers Association, and the American Association for the Advancement of Science (AAAS) and Achieve. This new rigorous set of standards, when integrated in science education, addresses science, technology, engineering and mathematical practices in the context of the

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broader concepts identified in the *Framework for K-12 Science Education.* The NGSS standards underwent several open comment sessions nationally for feedback while in draft status. With their release in May 2013, the NGSS provides both topical and disciplinary core content standards that can be used in designing science curriculum. The extensive supporting documentation provides a rich resource for educators to design meaningful learning and performance assessment opportunities with a strong dependence on conceptual development using STEM practices.

In view of the importance of the NH Science Framework, the Framework for K-12 Science Education, and the NGSS, the New Hampshire science competency workgroup considered all three documents in designing competency statements that will be used in curriculum design, performance assessment criteria, and design of appropriate learning opportunities.

The world of science and science education continues to undergo rapid changes and expansion. The proposed K-12 science competency statements are designed to reflect these changes but also the stability of the major cross-cutting themes in science. The newly released Next Generation Science Standards (NGSS) as well as New Hampshire's Science Standards emphasize that key scientific ideas, practices, and cross-cutting concepts must be integrated for meaningful science learning to occur. The New Hampshire Department of Education expects this type of integrated learning to be supported in New Hampshire classrooms, but has designed the NH K-12 Science Competencies to focus on the major cross-cutting concepts.

The New Hampshire Department of Education's rationale for focusing on the cross-cutting concepts is to limit the competency statements to the major ideas of science that transcend all scientific disciplines. However, the competency statements are not intended to stand alone, but must overlay New Hampshire's science education content standards and local curriculum. As such, schools will need to support students' deeper learning of the competencies and expect multiple performances by students to demonstrate that they have truly mastered the relevant competencies.

Science competencies offer a degree of complexity not found in the English language arts and mathematics standards because of the disciplinary nature of science. For example, if a student demonstrates a competency using life science content, but is unable to do so in physical or earth science, would we say the student has met the competency? This is a local decision, to some degree, but the guiding philosophy behind the science competencies is that students demonstrate their deep understanding of the competencies in ways that are convincingly multidimensional. In other words, students should be able to demonstrate they have met the competencies in ways that reflect their understanding of the key core ideas in life, physical, and earth/space sciences. Therefore, New Hampshire Department of Education makes clear that the following competency statements do not stand alone, but rely on the New Hampshire Science Content Standards to instantiate the NH K-12 Science Competencies. Science education should not be limited to these core disciplinary ideas, nor should students have to demonstrate mastery of each competency using all of the core ideas from the standards. Rather, the disciplinary core ideas should be used to demonstrate students' generalizable knowledge and skills related to the K-12 Science Competencies.

The NH Nationally Aligned Science competencies can function as conceptual drivers in the science disciplines of Life Science, Physical Science, and the Earth and Space Science. Educators, in recent presentations of these competencies, have found them to be very valuable for use in mapping science curriculum topics across grade levels in the K-12 continuum including at the course levels in high school curriculum. These competencies can also guide educators in creating local competencies that are concept or topic specific within a grade or course level and that are validated with the NH Competency Validation Tool.

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Work Group Tasks and Work Flow

On August 15-16, 2013, the work group examined the identified crosscutting or big ideas of science identified in the NGSS. These included:
- •Patterns
- •Cause-Effect
- •Scale, Proportion and Quantity
- •Systems and Models
- •Energy and Matter: flows, cycles, and conservation
- •Structure and Function
- •Stability and Change

Several members of the work group then chose a particular 'big idea' and researched the NH Frameworks for Science K-12 standards and process skills to identify connections in Life Science, Physical Science and Earth and Space Science. Once the connections were identified, potential performance tasks were then discussed.

From the report of each subgroup, preliminary competency statements were then sketched out. The criteria for the design of competency statements were aligned to the best practices in the field of competency education. In keeping with the criteria used in designing the College and Career Ready NH Competencies in English Language Arts and Math, ***competencies are targets for student learning representing key content-specific concepts and skills applied within or across content domains.***

Each competency statement begins with the construct: "Students will demonstrate the ability to…." The statement was subsequently validated using the NH Competency Validation Tool that uses four lenses to determine the strength of a competency statement:
1. Alignment to standards
2. Enduring nature
3. Assessment
4. Cognitive Demand

The Work Group's first set of draft competencies was further refined by cross referencing the current NH Department of Education's Minimum Standards for School Approval (2005) as well as the Minimum Standards for School Approval (2014), NGSS, the NH Frameworks for Science K-12, and *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.*

The refined set of competencies was then brought before the competency work group for further discussion and refinement on December 2, 2013. The work group felt that it was important to embed the science and engineering practices found in *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* as part of the competency statement in order to address interrelatedness between content and the scientific process of inquiry. These practices include:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations

4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

In reading the proposed NH Nationally Aligned K-12 Science Competency statements, note that there is emphasis on student ability to use evidence to support claims. This is an intended connection to the expectations of the Common Core State Standards in both Mathematics and English Language Arts. The Work Group felt that this performance expectation further reinforces critical thinking demanded by the Smarter Balanced Assessment Consortium.

The NH Nationally Aligned Science Competencies were extensively distributed for feedback from K-16 educators, including all 46 educators who expressed interest in this work. These educators were encouraged to distribute the draft competencies to their networks, discuss the competencies, and provide feedback to Rose Colby by February 10, 2014. The document was also distributed through the New Hampshire Science Teachers Association and posted to the Quality Performance Assessment networks for feedback . The document was further refined for clarity and ease of use and is submitted for approval to the NH Board of Education on April 24, 2014.

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Cross-Cutting Concepts	NH Nationally Aligned K-12 Science Competency Statements
Patterns	Students will demonstrate the ability to observe and describe patterns in natural and human designed phenomena and use those patterns to support claims about the observed or predicted relationships among phenomena.
Cause and Effect	Students will demonstrate the ability to investigate, explain, and evaluate potential causal relationships by using evidence to support claims and predictions about the mechanisms that drive those relationships.
Scale, Proportion, and Quantity	Students will demonstrate the ability to describe and represent the significance of changes in observable and non-observable phenomena in terms of relative scale, proportion, and quantity.
Systems and System Models	Students will demonstrate the ability to investigate and analyze a natural or human designed system in terms of its boundaries, inputs, outputs, interactions, and behaviors and use this information to develop a system model that can be used to understand and empirically evaluate the accuracy of models in terms of representing the underlying system.
Energy and Matter in Systems	Students will demonstrate the ability to analyze evidence from a variety of sources (investigations, models) to predict, connect and/or evaluate the cycling of matter and flow of energy within and between systems in order to understand, describe, or predict possibilities and limitations of systems.
Structure and Function	Students will demonstrate the ability to use evidence to support claims about the relationship among structure and function of natural and human designed objects.
Stability and Change of Systems	Students will demonstrate the ability to investigate and analyze static and dynamic conditions of natural and human designed systems in order to explain and predict changes over time.
Nature of Science	Student will demonstrate the ability to work collaboratively and individually to generate testable questions or define problems, plan and conduct investigations using a variety of research methods in a various settings, analyze and interpret data, reason with evidence to construct explanations in light of existing theory and previous research, and effectively communicate the research processes and conclusions.

REFERENCES

Competency Validation Rubric:
http://www.education.nh.gov/innovations/hs_redesign/documents/validation_rubric_for_course-level-competencies.pdf

Competency Validation Technical Advisory:
http://www.education.nh.gov/standards/documents/advisory20.pdf

College and Career Ready Competencies Aligned with Common Core State Standards in Mathematics:

http://www.education.nh.gov/competencies/documents/NHSBEApprovedMathFinal2.20.13.pdf

College and Career Ready Competencies Aligned with Common Core State Standards in English Language Arts:

http://www.education.nh.gov/competencies/documents/ela-competencies.pdf

Next Generation Science Standards Cross Cutting Concepts:

http://www.nextgenscience.org/sites/ngss/files/Appendix G - Crosscutting Concepts FINAL edited 4.10.13.pdf

Next Generation Science Standards Science and Engineering Practices:

http://www.nextgenscience.org/sites/ngss/files/Appendix F_Science and Engineering Practices in the NGSS - FINAL 060513.pdf

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