A primer on science education standards in Maine
February, 2018

I. Where do science standards come from?

In the early 1990's, curricular standards became vogue following the publication of the National Council of Teachers of Mathematics ground breaking *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989).

Science followed suit with the American Association for the Advancement of Science's Project 2061 that issued *Science for All Americans* and *Benchmarks for Science Literacy*. The National Academy of Sciences produced the National Science Education Standards shortly after.

The problem that these sets of standards tried to solve was the development of a cohesive and coherent learning experience for students in grades K-12, knowing that states and local districts were struggling with developing their own. The development of state and local standards meant there would be no coherence for students moving from state to state or district to district, no economies of scale in the research and production of effective learning materials, and no way to effectively compare science instruction across the nation.

Since education is a closely guarded constitution right under the 10th amendment, even these national efforts were used only as source material for state standards. For example, Maine drew heavily upon the *Benchmarks for Science Literacy* in development of its first Maine Learning Results in Science and Technology.

Although some of these efforts were funded by the federal government, specifically the National Science Foundation funded the 1996 *National Science Education Standards*, there was not the anti-federal fervor there is now.

In 2009, the private Carnegie Corporation of New York's Institute for Advanced Study Commission on Mathematics and Science Education released a report titled *The Opportunity Equation: Transforming Science and Mathematics Education for Citizenship and the Global Economy*. This document called for a new set of science standards, based on advances in the understanding of learning. Two reports from the National Academy of Sciences (NAS) Board on Science Education summarized these advances; *Taking Science to School: Learning and Teaching Science in Grades K-8* (2007) and *Learning Sciences in Informal Environments: People, Places and Pursuits* (2009).

The Carnegie Corporation, using non-federal funds, then commissioned the NAS's Board on Science Education to create a foundational document that would inform and guide development of a set of new science standards, based upon the latest research in cognitive and learning science and tapping into the Academy's science and engineering expertise.

The Board on Science Education convened a study committee of 18 members of which 9 were members of the National Academy of Sciences or the National Academy of Engineering, the highest honor for a scientist or engineer in America. Two of the members had won the Nobel Prize (one in chemistry and one in physics). The other nine members were distinguished cognitive or learning scientists, educational practitioners and educational policy researchers. They labored over 18 months to develop *The Framework for K-12 Science Education* (2012).

Among the many features of this report are:

- Learning needs to prioritize students constructing and applying knowledge by building explanation of phenomena and developing explanatory models
- Children are born investigators and building on and refining prior concepts needs to start in early grades
- Science and engineering require both knowledge and practice
- Three dimensions outline the knowledge and practices of the sciences and engineering that all students should learn:
    - Scientific and engineering practices
    - Crosscutting concepts
    - Disciplinary core ideas.

A feature of the *Framework* that is especially salient is the chapter titled Guidance to Standards Developers. This chapter describes many criteria and recommendations that are useful for any group developing standards. It starts with the assumption that the standards are based as much as possible on empirical, research-based evidence. Much of this evidence is in the *Framework*.

A feature of the process was the unprecedented convening of a team of leaders from the National Academy of Sciences, the American Association for the Advancement, Achieve, and the National Science Teachers Association. These are the premier, non-governmental science and science education organizations in America. Their expertise is unassailable.

Even before the Framework was released, the Carnegie Corporation funded Achieve to begin to lead the process to develop standards. Achieve is a non-profit that is led by half governors and half corporate CEOs. Achieve started the process through state leadership – and the writing team consisted of 40 from 26 lead state partners. This was not a federal process.

For more information, see https://nextgenscience.org/developing-standards/developing-standards.

Maine was an active participant in the Critical Stakeholder Review process. In fact, on a per capita basis, Maine submitted more feedback than any other state.

II. What does the NGSS do?

The NGSS take the three dimensions explicated in the Framework – scientific and engineering practices, disciplinary core ideas and crosscutting concepts, and craft a set of "performance expectations." These are targets for assessment, they are not a curriculum.

This is a significant point since how a teacher chooses to reach the performance expectation is a matter of curriculum and instruction. These are absolutely local decisions made by professional educators who work with children on a daily basis.

The NGSS have been crafted to be a cohesive and coherent set of standards. Educational research is emerging on the value of learning progressions and the NGSS take advantage of the latest relevant research.

III. What is the status of science education standards in Maine?

A bill was presented to the Education and Cultural Affairs (EDU) Committee of the First Regular Session of the 127th Maine Legislature (the 128th Legislature is meeting in its second session now) to adopt the NGSS. This bill received strong positive public support from many Maine teachers and administrators, business and industry such as Texas Instruments and the Maine State Chamber of Commerce, and organizations such as the governor-appointed Maine STEM Council and the Maine Science Teachers Association. In fact, adoption of the NGSS is the first recommendation of the Maine STEM Council.

This bill was reported out of committee as unanimous ought to pass. It passed easily on the House and Senate with little concern.

Governor LePage, however, vetoed it. The reason he gave was that teachers were devoted to implementation of the Common Core and had no time to develop new curriculum in science.

The House voted to override the veto since they knew how critical and timely this issue was. Several senators switched their votes to align themselves with the governor's opinion. And the veto was sustained.

Following the election of many new legislators, a new bill was introduced to the 128th Legislature to adopt the NGSS.

This time there was increased support for passage of the bill by more science educators, Texas Instruments and the Maine State Chamber of Commerce, the Maine STEM Council, the Maine Science Teachers Association, and the Maine School Superintendents Association.

The EDU committee voted this ought to pass although the Maine DOE attached a fiscal note regarding the cost of assessment to the bill. Due to this note, the bill was held over on the Appropriations Committee table. It is still there as of this writing.

The conventional wisdom is that this bill will die on the table, due to the fiscal note.

However, if it were to pass, Maine would adopt the NGSS and a review and re-write process would not be necessary and Maine students would be on their way to learning rigorous and high-quality science standards.

IV. What is the status of science standards in Maine?

According to the best data available, from a survey conducted by the Maine Science Teachers Association, 75% of Maine school districts have already adopted the Next Generation Science Standards. This admirable feat by Maine educators demonstrates their commitment to be well-informed and striving to best serve their students.

Along with this adoption of NGSS has been local spending for instructional materials, assessments, and professional development. It is impossible to calculate this amount, but one can imagine that it is in the hundreds of thousands of dollars considering the 75% adoption data.

Many districts have used the NGSS to identify the science proficiencies that students must meet for graduation. Even the MDOE has posted to its website sample science reporting standards that are essentially the NGSS. Districts have therefore been led to believe that the MDOE is supporting adoption and implementation of NGSS.

It should be noted that the NGSS are an effective and well-regarded set of science and engineering education standards. Any well-designed set of standards will attend first and foremost to internal coherence. This is well explained by 6 key features described in Systems for State Science Assessment, (NRC, 2006); the six features being:

- Be clear, detailed and complete,
- Be reasonable in scope,
- Be rigorously and scientifically correct,
- Have a clear conceptual framework,
- Be based on sound models of student learning, and,
- Describe performance expectations and identify proficiency levels.

The work of a teacher and learning by a student are hard enough with clear, coherent frameworks. Adding other standards such as computer science in a random way will negate the internal coherence of the NGSS and impede the work of teachers, students, and parents.