Preparing to teach in the "Next Generation" science classroom: insights from classroom practitioners

by Kathleen M. Browne, Wil van der Veen, Anne N. Catena, Cathlene Leary-Elderkin, Mary Yeomans, and Carrie Tretola

The Next Generation Science Standards (NGSS), created through a rigorous, transparent and inclusive national process, are now available for all states to consider, and to date, eight are adopting them. New Jersey is presently in the midst of its review process with a decision anticipated in 2014. Given the involvement of many New Jersey science education leaders in early reviews of NGSS drafts, it is anticipated that principles from the NGSS will heavily influence a next revision of the science Core Curriculum Content Standards scheduled for 2014, which would be needed if the state chooses not to adopt the NGSS.

That means districts will need to adjust to new standards that are at least similar to the NGSS. Implementation of either set of standards is not expected to begin until the 2015–16 school year, thus districts have the opportunity to carefully plan for the significant science program transformations that can be expected and to prepare teachers to make a successful transition. The purpose of this article is to share perspectives from New Jersey teachers and administrators involved in a project designed to help 13 districts carefully plan together for this transition.

the need

The NGSS and its foundational Framework for K–12 Science Education present a vision of science education where students develop a progressively deeper understanding of science over multiple years. This is accomplished by actively engaging students in science and engineering practices to deepen their understanding of disciplinary core ideas, crosscutting concepts, and the nature of science (the multiple dimensions of the NGSS). The NGSS and Framework provide a guide to expectations for K–12 science education that is more coherent and informative than current New Jersey standards and will require significant, long-term efforts to align to them. Performance expectations provided in the NGSS, which serve as "specifications for assessments," integrate multiple dimensions to clarify what students are expected to do with newly gained understandings, but are not considered instructional strategies or objectives for a lesson.

If implemented appropriately, the NGSS will likely impact nearly every aspect of a K–12 science program. Curriculum revisions that are needed to successfully implement the NGSS will require notably more time and consideration than in the past. District leadership and all teachers of science will need substantial support to revise their science program and implement it effectively. Reviewing current science programs and prioritizing needs to align them with the NGSS are essential steps for teachers to effectively transition to new standards in ways that benefit our students. Doing so with input from classroom practitioners is imperative to not only leverage their wisdom but also identify areas for which most teachers will need support.

science program gap analyses

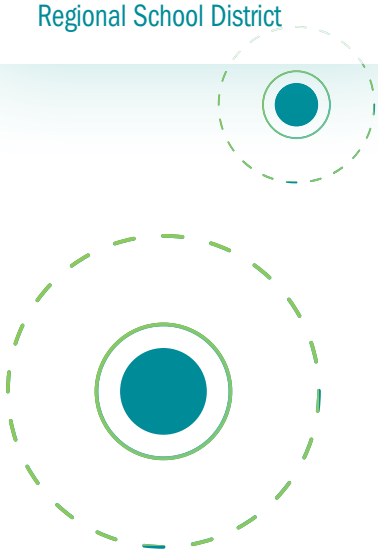
Rider University's Science Education and Literacy Center (SELECT), in partnership with Princeton University's Teacher Preparation Program and the Science Education Institute at Raritan Valley Community College, have begun helping 13 New Jersey districts (see list on next page) conduct a gap analysis of their K–12 science programs to determine what it will take to effectively implement the NGSS. Using NGSS resources available through Achieve (*www.nextgenscience.org*), the National Academy of Sciences (*www.nap.edu*), the National Science Teachers Association (*ngss.nsta.org*), and key principles of gap analyses, we designed a six-day program to guide district administrators and teachers through an analysis of their current science programs. This extended study has helped districts look in a mirror long enough to develop a detailed view of where they stand and what they will need to consider for implementation. Additionally, our process has revealed professional development needs that we can design together to meet districts' and teachers' most pressing needs.

In their studies, district teams of teachers and administrators have reviewed:

- Integrated dimensions of the Framework: science and engineering practices;

Rider SELECT's NGSS Gap Analysis Project Districts

- Chesterfield Township School District
- Ewing Township Public Schools
- Flemington-Raritan Regional School District
- Hamilton Township School District
- Hillsborough Township Public Schools
- Hopewell Valley Regional School District
- Mansfield Township School District
- Montgomery Township Schools
- The Newgrange School
- Northern Burlington County Regional School District
- North Hanover Township Schools
- Springfield Township School District
- West Windsor-Plainsboro Regional School District



crosscutting concepts; the nature of science; disciplinary core ideas (DCIS) in science and engineering

- NGSS Student Performance Expectations
- Aspects of their science programs to identify gaps in alignment (e.g. curriculum; instruction; assessment; professional development; new teacher qualifications; budget; community and communication)
- Districts' present curriculum and instruction during four separate grade band reviews (K–2; 3–5; 6–8; 9–12) of the NGSS.

We addressed the first three bulleted components during a two-day session for administrators in July 2013. Having studied the Framework for K–12 Science Education as part of their preparations, district administrator teams (composed of science supervisors, principals, and/or assistant superintendents) considered the degree to which aspects of their present science programs address the Framework dimensions and NGSS performance expectations. They identified gaps in their programs and determined what additional research would be needed to refine their preliminary findings and consider possible actions to address their needs. As they continue their refinements and action plan development, their work is being compiled in a multi-district composite gap analysis and action plan for all participating districts to access.

Since instructional resources and district curriculum typically drive what actually takes place in classrooms, four grade-band sessions were designed to dive deeper into these areas to reveal any unique circumstances for each grade or grade band. Two teachers from each grade band (K–2, 3–5, 6–8, HS) working with their district administrators have been guided to analyze district materials looking for alignment (or lack of alignment) with the NGSS in separate day-long sessions. Thus far 69 teachers have participated. Results from the July administrator session led us to focus on a subset of topics with teachers in each one-day program including: an introduction to the Framework, disciplinary core ideas in science and engineering, the NGSS in their grade band, and the science practices. Team administrators report that they have gained additional insight into the potential impacts of the NGSS on their science program through the eyes and minds of classroom practitioners. K–5 teachers have contributed thus far, and 6–12 teachers will join the effort in spring 2014. After completing all components of the program, district teams should be in a position to use their complete gap analysis and action plan to prepare to implement the standards.

preliminary insights

We expected that teachers working collaboratively with their supporting administrators would pool their wisdom and experience to uncover major insights about where their districts stand and what a future with the new standards could mean for teachers and students. And indeed they did! Insights from the teachers and administrators are summarized in the chart on the next page.

From their studies thus far, both teachers and administrators recognize that implementing the NGSS will require significant adjustments in instructional materials and strategies; teacher content knowledge; and classroom, school and district culture. They also see that the NGSS set high expectations for all students and thus will require substantial efforts by teachers and sustained and comprehensive support from districts and community partners. In fact, these conclusions align with recommendations in the Framework, the NGSS, and Rodger Bybee's just released *Translating the NGSS for Classroom Instruction*. Our participating grade K-5 teachers indicate that the highest professional development priorities are:

- Education on the Framework and NGSS
- New content knowledge
- Time for planning
- Adaptation of existing instructional resources
- Guidance to use new teaching resources
- Model lessons, particularly to demonstrate science and engineering practices
- Vertical articulation and producing one coherent K–12 science program
- Integration with instruction of language arts and mathematics where appropriate, and
- Instruction on guiding student questioning and experimentation.

(continued)

TEACHER AND ADMINISTRATOR FINDINGS

Crosscutting concepts	• Are not addressed and/or made explicit in current science programs
Science practices & nature of science	• Most are not explicitly addressed • Engaging students in the practices will require enhanced teacher content knowledge • Expectation that students ask testable questions and define problems is a significant change • Practices mirror emphasis on a student-centered classroom in teacher evaluation models
Disciplinary core ideas—life, physical & earth science	• Notable redundancies of topics through the grades in current curriculum • More content is currently taught than the NGSS address • Current curriculum content is not aligned to NGSS sequence in numerous places • Earth science is missing from grades 9–12 • Request help creating lessons to meet the DCIS • Since kindergarten is not mandatory and/or varies even between schools in a single district, expectations for this grade will be difficult to manage
Disciplinary core ideas–engineering	• Missing in K–12 • Request help identifying appropriate lessons • Existing lessons typically define the problem and are not tied to grade level appropriate science &/or math content • Expectations are higher for the complexity of high school problems • Creating a learning environment where "design failure" is recognized as a natural step in the design process is needed
Reactions to NGSS	• For curriculum revisions, clarification statements and links to Common Core, grade level specificity and coherent design of three integrated dimensions of NGSS will be very useful • Request help in identifying new classroom resources aligned to the NGSS
NGSS as compared to NJ 2009 Science CCCS	• Fewer topics in NGSS allow for more in-depth study • NGSS have higher expectations, and are more rigorous
Likely biggest impacts	• Higher expectations for sophistication of content addressed at many grade levels • Curricula will need much realignment • Teachers recognized that extensive sustained professional development will be needed to prepare for implementation
Summary insights	• Implementing the NGSS will require a paradigm shift in how our students learn and how we assess their learning • To implement, sustained, comprehensive efforts will be needed district-wide; teachers will need common planning time; and parents need to be informed and involved • We are being asked to fundamentally change teaching

The K–5 teacher participants thought the following messages would be important to deliver to other teachers:

- The number of standards is reduced, which should free up time for your students to learn concepts more deeply.
- With proper implementation, the NGSS will produce a community of scientific thinkers and problem solvers.
- Successful implementation will require a gradual transition with sufficient sustained teacher support and parent education.
- Productive talk and argumentation are notable commonalities with the Common Core.
- State assessments will not change right away so big changes in the curriculum should be considered carefully.

District draft gap analyses developed with input from teachers show an emphasis on developing communication plans to inform all administrators and parents; planning for actions that require funds to implement; engaging district teams to develop internal expertise for curriculum and assessment alignments needed; and planning PD that teachers will need. (We anticipate that middle and high school teachers who join the program this spring will provide additional insights and

recommendations.) Such a mid-program outcome illustrates the scope of work needed to simply plan for implementation. Program participants have found value in collaborating with each other and with other districts and from the availability of program guidance, materials and time reserved for this work. They noted that our emphasis on student learning, the big picture view of the NGSS, and the combined expertise offered were additional strengths. Finally, teachers indicate that they found their one-day grade-band session to be a helpful introduction to the NGSS.

next steps

Middle school and high school teachers will add their insights after which districts will complete their gap analyses and action plans with additional support from this program. And because the gap analysis process is functioning for us as a "needs" assessment with district representatives identifying the PD they will need to implement the NGSS, we will be able to quickly respond.

We recommend that every district undergo a systematic analysis of their science program with teachers' input to prepare for the NGSS. Resources created for our approach are available upon request. ■

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