Five Tools and Processes for Translating the Next Generation Science Standards into Instruction and Classroom Assessment

FOREWORD

Introduction

With the 2012 release of *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, the science education community received an early warning of the impending challenges of contemporary educational reform. The framework presented three categories of learning outcomes: science and engineering practices, crosscutting concepts, and disciplinary core ideas. It recommended integrating these three categories into performance expectations—that is, as standards for K–12 science education. A year later, the framework's recommendations were presented as the Next Generation Science Standards.

The science education community now has to respond by translating the Next Generation Science Standards (NGSS) into understandable and usable science curriculum programs and classroom teaching practices. Central to this translation is providing science teachers with the knowledge and abilities they will need to implement new programs and practices. There is a critical need for professional development as well as resources and tools designed to support this era of science education reform.

The Challenge: Addressing the NGSS Innovations

Implementing the NGSS requires educators to address five innovations. I suggest using the term *innovations* because, compared to the 1996 National Science Education Standards, there are new and different characteristics to the NGSS. To be blunt, educators are cautioned not to review the NGSS and say, "We are already doing that," because they aren't. To capture these innovations in a few words, the NGSS integrates **three-dimensional learning**; emphasizes **student experiences with phenomena**; includes **performance expectations**; includes the **nature of science and engineering** with traditional science content; describes **learning progressions** for grades K through 12; and makes **connections between science and English-language learning and mathematics**. Let me briefly explain these innovations.

First, implementing curricular programs and classroom teaching practices based on the NGSS requires an integration of science and engineering practices, disciplinary core ideas, and crosscutting concepts. These three domains represent learning outcomes. The new standards, presented as performance expectations, include these three dimensions. Here is an example for middle school life sciences, specifically Heredity: Inheritance and Variation of Traits.

Figure 1. Middle School Performance Expectation

PERFORMANCE EXPECTATION
MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of an organism.

This performance expectation first presents a science and engineering practice: *Develop and use a model to describe phenomena* (genetic mutations). Second, it presents a disciplinary core idea: *Genes are located in the chromosomes of cells; genes control the production of proteins, which in turn affect the traits of organisms*. Finally, the standard includes a crosscutting concept: *structure and function*.

So, what is the connection to science teachers? This innovation directs professional developers' attention to the role of, and strategies for, instruction, and the need for examples of instructional sequences that exemplify three-dimensional teaching. In this example, teachers are asked to design an instructional sequence that gives students opportunities to create and use a model to show the results of structural changes to genes.

Second, implementing the NGSS emphasizes experiences with natural and designed phenomena and the expectation that student learning will be enhanced and assessed. Here, with the standards expressed as performance expectations, students will study phenomena, and assessments will include three dimensions. From the point of view of professional development, this innovation underscores the context for instruction and the importance of including meaningful experiences for all students.

Third, the NGSS incorporates the nature of science and engineering design as part of science and engineering practices and crosscutting concepts. Science teachers have expressed concerns about their understanding of engineering and the nature of science. These concerns extend to the processes and strategies for teaching about these domains, with implications for professional development.

The fourth innovation involves learning progressions that include statements about the three dimensions and the nature of science and engineering design in grade-level bands for K–12 programs. This innovation should be addressed by redesigning the school science curriculum and classroom assessments. Specifically, there is the need for universal coherence and coordination of content and assessments across the K–12 continuum.

Finally, the NGSS makes explicit connections to the contemporary emphasis on mathematics and English-language arts. Although the Common Core has come under political criticism, the need to improve mathematics and English-language achievement remains a priority in American education. Activities in science present excellent opportunities to introduce math content in a meaningful context and provide students with opportunities to engage in meaningful nonfiction reading and writing in science.

The Response: Providing Tools for Professional Development

In collaboration with BSCS and the K–12 Alliance at WestEd, the Gottesman Center for Science Teaching and Learning at the American Museum of Natural History developed and field-tested five tools and processes for professional development leaders. These tools are a timely and appropriate response to the challenges of translating the NGSS into instruction and classroom assessment. These tools and processes establish a meaningful context for teachers of science to develop an understanding of the framework and the NGSS, as well as a means to begin implementing changes in their classrooms.

Tool 1 has participants plan a unit or blueprint for classroom instruction based on the NGSS. This context immediately responds to teachers' initial concerns, namely, "How do we get started on implementing the NGSS in our classrooms?" As participants begin planning their unit, they must, of necessity, read selections from *A Framework for K–12 Science Education* and the Next Generation Science Standards. The plan for a unit of instruction may be rough and general, but the first tool sets a meaningful stage for developing the knowledge and abilities needed to translate the NGSS into practice.

Tool 2 responds to teachers' second major concern: "How will assessments change?" Using performance expectations from the NGSS, participants plan assessments for classroom instruction. Participants are challenged to determine what counts as evidence for student learning, and how to develop evidence of learning specifications that show students have indeed learned the science and engineering practices, crosscutting concepts, and disciplinary core ideas expressed in performance expectations.

In **Tool 3**, the BSCS 5E instructional model takes center stage. The 5E model provides a concrete and meaningful guide for participants. Teachers' professional lives center on instruction, and the 5E instructional model is built on a sequence of lessons and is based on a foundation of research about learning. Tool 3 extends the initial experience of planning a curriculum unit by helping teachers develop a conceptual flow of the science content and refine a storyline about a phenomenon.

Tool 4 brings these prior experiences together, as participants use Tool 1 (the unit blueprint) and Tool 3 (the 5E instructional model and conceptual flow) to develop an instructional sequence for a section of the unit plan. By placing an emphasis on what teachers do and what students do in each phase of the 5E instructional model, participants gain a deeper understanding of what three-dimensional teaching is, and how to implement the teaching of phenomena in science classrooms.

In **Tool 5**, participants return to Tool 2 (evidence of learning specifications) and the performance expectations used as the basis for their unit. They create three dimensional performance tasks that serve as summative assessments for each of the instructional sequences in their unit.

Conclusion: Beyond the Next Generation Science Standards

Developing and releasing the Next Generation Science Standards fulfills the first step in a much longer process of improving science teaching and student learning. Yet between the new standards and student learning lies the need for professional development for science teachers. As I see the situation, this need for professional development creates a paradox. The changes in instruction called for by the standards must be implemented at the level of individual teachers in K–12 grade levels. Yet recommending personal professional development for individual teachers is unrealistic. On the other hand, presentations for groups tend to leave some teachers with the feeling that their unique concerns and different disciplines have not been addressed. This set of professional development resources, "Five Tools and Processes for Translating the NGSS into Instruction and Classroom Assessment," addresses these individual concerns within a group context in what I think is an appropriate and adequate response to the paradox.

Science teachers have the challenge of implementing reforms to their curricular programs and making changes to their instruction that will bring about learning for the 21st century. They may be able to meet these challenges alone, but I say that with concern and doubt. With the support of strong professional development leaders, using effective tools and processes with teachers, this concern is reduced and doubt becomes hope.

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