Additional Information About the New Science Standards

The Next Generation Science Standards* (NGSS; NGSS Lead States, 2013c) were released in April of 2013 after an extensive multiyear process of research and development. Here, we discuss three aspects relevant to the history of the NGSS: (1) distinguishing features of the NGSS, (2) reception of the NGSS, and (3) adoption and implementation of the NGSS.

Distinguishing Features of the NGSS

Several features of the NGSS distinguish them from previous standards documents for science education. These features include:

- Integration of content and practices
- Smaller number of topics
- Establishment of a coherent learning progression
- Alignment to the Common Core State Standards (CCSS)
- Focus on engineering as a key facet of science education

In the following sections, we elaborate on each.

Integration of Content and Practices

One of the most widely discussed hallmarks of the NGSS was their incorporation of specific scientific practices into science knowledge. *Practices* (skills) refer to what students are expected to do, whereas *knowledge* (content) refers to what students are expected to know. Most previous science standards documents did little to emphasize scientific practices (Henderson, 2013). The framework created by the National Research Council (NRC, 2012), *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, however, challenged this perspective: "Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge" (p. 26). Because this framework served as an outline to guide the development of the NGSS, science knowledge and scientific practices were woven together in the standards themselves. In other words, every standard delineates cohesive expectations for engaging in skills and understanding content.

One benefit of this approach, according to the NRC framework, was that it allowed educators to teach a multitude of different skills associated with science, rather than limiting them to one skill or narrow set of skills:

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> A focus on practices (in the plural) avoids the mistaken impression that there is one distinctive approach common to all science—a single "scientific method"—or that uncertainty is a universal attribute of science. In reality, practicing scientists employ a broad spectrum of methods, and although science involves many areas of uncertainty as knowledge is developed, there are now many aspects of scientific knowledge that are so well established as to be unquestioned foundations of the culture and its technologies. (p. 44)

Rather than focus solely on a uniform model of experimentation, the NRC tried to accommodate the variety of "common features" that all sciences share "at the core of their inquiry-based and problem-solving approaches" (NRC, 2012 p. 26). Consequently, the organization suggested that science educators broaden the umbrella definition of scientific practices to include skills such as questioning, communicating, evaluating, modeling, analyzing, problem-solving, interpreting data, and defending claims with evidence. For instruction on how to directly teach scientific and engineering practices in the classroom, see the companion publication to this document, *Proficiency Scales for the New Science Standards* (Marzano & Yanoski, 2015).

Smaller Number of Topics

A second important characteristic of the NGSS initiative was their attempt to hone in on a limited number of content areas in science. This emphasis on "depth over breadth" (Robelen, 2013a) aimed to encourage teachers to spend more time developing and refining students' understanding of core ideas. On the limited numbers of content areas, the NRC (2012) stated:

> The framework focuses on a limited set of core ideas in order to avoid the coverage of multiple disconnected topics—the oft-mentioned mile wide and inch deep. This focus allows for deep exploration of important concepts, as well as time for students to develop meaningful understanding, to actually practice science and engineering, and to reflect on their nature. It also results in a science education that extends in a more coherent way across grades K–12. (p. 25)

Furthermore, the NRC proposed additional benefits to the restricted number of topics that would eventually be articulated in the NGSS. Most obviously, the smaller number of topics taught per year would prevent teachers from struggling to cover a multitude of unrelated topics in a limited amount of time. The NRC (2012) also added that the choice to limit topics was influenced by "studies comparing experts and novices in any field" (p. 25). Experts, the organization contended, "understand the core principles and theoretical constructs of their field," while novices "hold disconnected and even contradictory bits of knowledge as isolated facts" (2012, p. 25). By narrowing the scope of science topics to a small set of clearly connected concepts, the NRC hoped that students would "become less like novices and more like experts" (NRC, 2012 p. 25).

Establishment of a Coherent Learning Progression

The NRC's framework focused on the idea of "learning as a developmental progression" (NRC, 2012, pp. 10–11), meaning that students need to make content-related connections over a period of years, rather than within a single unit, to truly master fundamental concepts. As such, the NGSS initiative aimed to articulate a logical progression of science knowledge across grade levels, the third distinguishing feature of the standards document. The NRC (2012) elaborated:

> In grades K–2, we choose ideas about phenomena that students can directly experience and investigate. In grades 3–5, we include invisible but chiefly still macroscopic entities,

> such as what is inside the body or Earth, with which children will have had little direct experience. When microscopic entities are introduced, no stress is placed on understanding their size—just that they are too small to see directly. However, pictures, physical models, and simulations can represent the entities and relate them to phenomena that the students can investigate and interpret. In grades 6–8, we move to atomic-level explanations of physical phenomena and cellular-level explanations of life processes and biological structures, but without detail on the inner workings of an atom or a cell. Finally, in grades 9–12 we shift to subatomic and subcellular explanations. A similar progression of scales and abstraction of models applies in addressing phenomena of large scales and deep time. (pp. 33–34)

In addition to developing content knowledge across grade levels, the NRC (2012) also outlined a coherent learning progression for scientific practices:

> The progression for practices across the grades follows a similar pattern, with grades K–2 stressing observations and explanations related to direct experiences, grades 3–5 introducing simple models that help explain observable phenomena, and a transition to more abstract and more detailed models and explanations across the grades 6–8 and 9–12. (p. 34)

By specifying learning progressions for both content and practices, the NGSS sought to create cohesive curriculum parameters that would allow teachers to build upon students' previous science knowledge and scientific skills in a logical and cohesive way.

Alignment to the Common Core State Standards

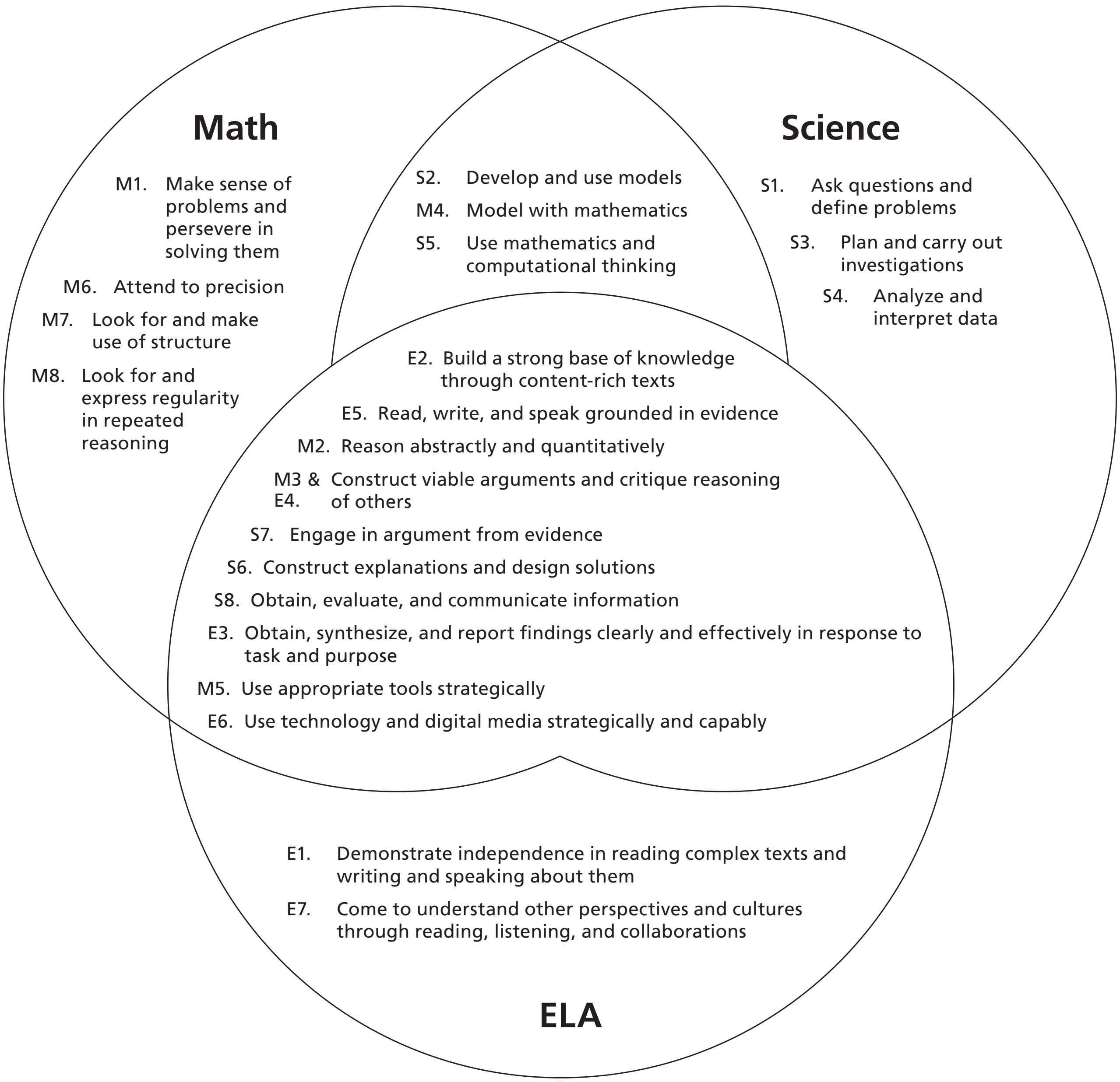
The fourth defining characteristic of the NGSS was their alignment to the Common Core State Standards (CCSS; National Governors Association Center for Best Practices & Council of Chief State School Officers [NGA & CCSSO], 2010a, 2010b), a U.S. initiative that developed national standards for English language arts (ELA) and mathematics. The CCSS initiative was primarily sponsored by the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO), as well as by Achieve, the Alliance for Excellent Education, the James B. Hunt Jr. Institute for Educational Leadership and Policy, the National Association of State Boards of Education, the Business Roundtable, ACT, and the College Board (Rothman, 2011). Shortly after the CCSS were published in 2010, they were adopted by forty-five states across the United States.

Although the CCSS focused mainly on ELA and mathematics, a few of the standards related to other content areas, as the CCSS included standards for literacy in history and social studies, science, and technical subjects to supplement the reading and writing expectations within the ELA standards. However, it is critical to note that the CCSS for literacy in science were never meant to "replace science standards," but instead only to "supplement them" (Achieve, n.d.a). In fact, the literacy standards in the CCSS were actually written "to help students meet the particular challenges of reading, writing, speaking, listening, and language in their respective fields" (NGA & CCSSO, 2010a, p. 3). In other words, the CCSS literary standards merely encouraged an interdisciplinary focus on cultivating literacy across all content areas.

The NRC (2012) stated that "the anticipation of a similar effort [to the Common Core] for science standards was a prime motivator" (p. 19) for the NGSS initiative. Therefore, in drafting the NRC framework—and subsequently the standards themselves—developers of both documents prioritized alignment between the NGSS and the CCSS in ELA and mathematics. According to the NGSS Lead States (2013b):

> The NGSS content is focused on preparing students for college and careers. The NGSS are aligned, by grade level and cognitive demand with the English Language Arts and Mathematics Common Core State Standards. This allows an opportunity both for science to be a part of a child's comprehensive education as well as ensuring an aligned sequence of learning in all content areas. The three sets of standards overlap and are reinforcing in meaningful and substantive ways. (p. 2)

Figure 1 depicts the specific relationships between the NGSS and the CCSS for ELA and mathematics.



Source: NGSS Lead States, 2013a, p. 21.

Figure 1: Relationships and convergences found in the CCSS for Mathematics, CCSS for English Language Arts and Literacy, and the NRC framework.

As depicted in figure 1, communication skills, development of a strong knowledge base, argumentation, synthesis of information, abstract reasoning, and use of appropriate technology and tools were emphasized within the NRC framework and the CCSS for ELA and mathematics. Additionally, the mathematics portion of the CCSS and the NRC framework overlap in their emphasis on designing and using models as well as on thinking mathematically and quantitatively. Alignment of these standards documents allowed states to adopt any of the three documents as they saw fit to create coherent curricula and facilitate teacher collaboration across multiple disciplines.

Focus on Engineering as a Key Facet of Science Education

Finally, in contrast to previous science standards documents, the NGSS focused on engineering as a major field in science. The appearance of engineering topics in science standards documents was not entirely original; the American Association for the Advancement of Science (AAAS) *Benchmarks for Science Literacy* (1993, 2009) contained some engineering standards in a section called "The Designed World." Even so, the NGSS uniquely prioritized engineering—alongside physical, life, and Earth and space sciences—as one of the four overarching disciplines of science education.

In its framework, the NRC (2012) defined engineering as "any engagement in a systematic practice of design to achieve solutions to particular human problems" (p. 11). In other words, engineering is the application of science to meet human needs. Because the NRC committee essentially defined engineering as applied science, the distinction between scientific practices and engineering practices may seem unclear. However, the committee argued that there are substantial differences between engineering design and scientific inquiry. It offered the following clarification:

> In engineering, the goal . . . is to evaluate prospective designs and then produce the most effective design for meeting the specifications and constraints. This optimization process typically involves trade-offs between competing goals, with the consequence that there is never just one "correct" solution to a design challenge. Instead, there are a number of possible solutions. . . . The aim of science is to find a single coherent and comprehensive theory for a range of related phenomena. (NRC, 2012, p. 48)

To this distinction, Achieve (n.d.a) added, "scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design."

The NRC (2012) justified their focus on engineering in the following ways:

> First, the committee thinks it is important for students to explore the practical use of science, given that a singular focus on the core ideas of the disciplines would tend to short-change the importance of applications. Second, at least at the K–8 level, these topics typically do not appear elsewhere in the curriculum and thus are neglected if not included in science instruction. Finally, engineering and technology provide a context in which students can test their own developing scientific knowledge and apply it to practical problems; doing so enhances their understanding of science—and, for many, their interest in science—as they recognize the interplay among science, engineering, and technology. We are convinced that engagement in the practices of engineering design is as much a part of learning science as engagement in the practices of science. (p. 12)

In addition to these reasons, the international benchmarking report conducted by Achieve (2010) also encouraged engineering as a key facet of the NGSS. The results of the benchmarking report identified that "development of inquiry and design processes in parallel to facilitate students engaging in both science and engineering practices" (Achieve, n.d.a) was common to countries with particularly strong student performance in the sciences. Indeed, a desire to be competitive internationally was a final factor that drove the focus on engineering within the NGSS.

Reception of the NGSS

As Robert J. Marzano, David C. Yanoski, Jan K. Hoegh, and Julia A. Simms (2013) reported, the idea of creating common education standards across the states has historically drawn support as well as criticism:

> Although the flaws in the early standards efforts caused some to question the validity of standards-based education, many recognized that creating a common set of U.S. national standards could remedy many of these issues [associated with state-to-state variance in standards]. Specifically, many agreed that national content standards could be written to alleviate the problems of too much content, too many standards, and multidimensionality. . . . Not all were supportive of the idea of common standards, however. Loveless (2012) explained that those who believe that "local school governance is preferable to governance by larger entities" (p. 9) were critical of the idea of national standards. (p. 5)

In addition to these responses to common standards endeavors in general, many offered feedback on the NGSS specifically. Much like the CCSS, the NGSS received a wide variety of reviews from researchers, reviewers, educators, and others, which ran the gamut from fully supportive to firmly negative. Here we discuss the general support and criticism for the NGSS and briefly touch on two of their more controversial aspects.

Support for the NGSS

Shortly after the standards were released, the National Science Teachers Association (NSTA, 2013; one of four NGSS partner organizations) Board of Directors published a very positive endorsement of the standards:

> Science is a key component of a complete and rigorous curriculum for all students. The *NGSS* works in tandem with *Common Core State Standards* in mathematics and English language arts to facilitate integrated teaching and learning. Because of this essential connection that supports student learning, NSTA recommends the adoption of the *Common Core State Standards* by states and school districts.

Like NSTA, all of the partner organizations—perhaps predictably—were particularly vocal in endorsing the NGSS. However, there was "no shortage of high praise for the standards" (Robelen, 2013c) from third parties after their release. Achieve (2013) collected and published lists of various NGSS supporters, including scientific, engineering, and education organizations; prize-winning scientists; academics from esteemed universities; and a long list of corporations including Comcast, Microsoft, State Farm, and 3M. Additionally, Achieve (n.d.b) gathered web-based submissions from the public, including teachers, school leaders, and citizens, and posted a list of positive quotes and testimonials on the NGSS website.

The U.S. educational newspaper *Education Week* published a favorable review of the NGSS. In it, Arthur H. Camins (2013) offered three specific reasons the NGSS "have the potential" to yield improvements in science education:

> First, . . . they would promote scientific thinking, which is the bedrock of informed democratic participation. . . . Specifically, their existence will emphasize that scientific practice is about building, testing, debating, and revising explanations about the natural world through evidence-based reasoning. . . . Second, the standards will elevate the importance of understanding the engineering design process. . . . Third, the next-generation standards will push at the boundaries of learning in two significant ways. . . . They do so by carefully sequencing learning from novice to more-sophisticated concepts across the K–12 spectrum and by setting the expectation that students will learn more deeply by using their knowledge to actively investigate real scientific questions and engineering problems in multiple and varied contexts.

While many individuals and organizations offered support after their publication, others were not as satisfied and criticized aspects of the NGSS.

Criticism of the NGSS

Most famously, the NGSS received criticism for their stance on global climate change and evolution and their lack of computer science content. However, the Thomas B. Fordham Institute review of the NGSS also served as a notable criticism worthy of discussion.

Stance on Global Climate Change and Evolution

Perhaps most controversially, there has been a long-standing debate surrounding the new science standards' stance on global climate change and evolution. Unlike many previous state science standards, the NGSS was the first science standards document that recommended students be taught about global climate change as early as middle school and that took "a firm stand that children must learn about evolution" (Gillis, 2013). While this stance received praise from numerous organizations, critics argued the NGSS "do not present the issue of human influence in global warming objectively and do not consider 'all sides' when discussing evolution" (Bidwell, 2014). Here, we further discuss the debates surrounding the position of the NGSS regarding global climate change and evolution.

One of the earliest and most outspoken critiques of the NGSS came from Heather Mac Donald (2013), a fellow at the Manhattan Institute, who expressed that the NGSS's emphasis on global climate change represented a liberal and progressive "political choice, not a scientific one." Joy Pullman, a research fellow at the Heartland Institute, further questioned the presentation of human activities as "major factors" in global climate change and maintained that the NGSS integrated "alarmist global warming [ideas]" into their standards (as quoted in Robelen, 2013b). However, while critics argued that the NGSS unfairly addressed global climate change, and particularly the role of humans in affecting this change, various organizations and individuals—a majority of which were involved in environmental activism or science advocacy—stepped forward to endorse the standards. Proponents hoped that the explicit inclusion of global climate change could "fill a critical gap in public awareness" (Gillis, 2013).

Similar to the ongoing debates about the NGSS's stance on global climate change, another deeply divisive and politicized topic involved the document's inclusion of the theory of evolution. Arguments surrounding this topic are by no means new to the field of education. Since the famous Scopes trial of 1925 in which a substitute teacher was found in violation of a Tennessee law prohibiting the teaching of Charles Darwin's work, evolution in the classroom has been a highly visible and controversial topic. As such, various religious groups asserted that the presentation of evolution in the NGSS presented an atheist worldview (Todd, 2014). However, other religious groups endorsed the standards. In Wyoming, where adoption of the NGSS became a heated debate between politicians, educators, parents, and scientists, the Wyoming Association of Churches offered their support of the NGSS as they felt "science should be taught openly and not be based on any belief system" (Todd, 2014).

While "the climate and evolution standards are just two aspects of a set of guidelines containing hundreds of new ideas on how to teach science" (Gillis, 2013), they are highly contentious issues that are deeply entrenched in personal belief systems. To address these discrepancies in belief systems, state legislatures have seen a rise in the introduction of "academic freedom" bills, which allow educators to teach creationism or refute global climate change in individual classrooms or schools (Morello, 2013). Disagreement with the stance of the NGSS on global climate change and evolution also manifested in slow approval or outright rejection of the new standards document in some states.

Lack of Computer Science Content

Another criticism of the NGSS concerned the omission of computer science content from the standards. The NRC (2012) committee explained its belief that computer science belonged more to the domain of mathematics and had "a history and a teaching corps that [were] generally distinct from those of the sciences" (p. 15). However, various organizations and corporations—noting the lack of computer science in the CCSS in mathematics—criticized this stance, despite the few elements of computer science found in the NGSS. The Computing in the Core Coalition, for example, protested that "the attention paid to the discipline of computer science does not match its importance in terms of workforce demand and the opportunities it presents young people in the 21st Century" (Computing in the Core, 2012).

In an interview with NPR, Chris Stephenson, director of the Computer Science Teachers Association, stressed that computer science is a scientific discipline, pointing out that "having access to a computer isn't the same as learning computer science any more than having a Bunsen burner in the cupboard is the same as learning chemistry" (quoted in Westervelt, 2014). The absence of computer science in the NGSS impacts low-income students in particular. As Eric Westervelt (2014) commented, "Never mind the hardware-based digital divide, there's a growing digital information divide. Computer science education, it seems, is now privileged knowledge accessible mostly by affluent kids." Without additional standards documents designed specifically to integrate computer science into science or math curricula, it stands that this gap will only continue to widen.

The Thomas B. Fordham Institute Review of the NGSS

Perhaps the most prominent criticism of the NGSS was written by the Thomas B. Fordham Institute (Fordham), a "longtime critic of the quality of most state science standards" (Robelen, 2012b). Fordham is known specifically for using letter grades to rank various state standards across the United States. Previously, the institute expressed optimism about the CCSS, calling them "substantively strong and truly state-owned" (Finn & Porter-Magee, 2013, p. 14). Similarly, when the Thomas B. Fordham Institute reviewed the NRC framework (2012), the author of the review took a fairly positive stance, stating, "The new Framework is an impressive policy document, a collective, collaborative work of high quality, with much to recommend its vision of good standards for the study of science" (Gross, 2011, p. 10). However, Fordham expressed reservations about the NRC framework, specifically about how it would eventually translate to a standards document and whether the emphasis on practices would mislead educators (Gross, 2011).

Throughout the development process, Fordham reviewed the NGSS multiple times, eventually conducting an official review in 2013 after the standards were finalized and released to the public. The review was less than favorable, primarily due to what the reviewers saw as "the standards' wrongful prioritizing of 'practices' over knowledge" (Finn & Porter-Magee, 2013, p. 8), a previous concern articulated in the Fordham review of the NRC framework. The authors of the Fordham review of the NGSS elaborated:

> Good science consists of doing as well as knowing, of practices as well as content and concept, and well-taught K–12 science has long understood and incorporated this truth. But doing it well requires a careful balance that seems somehow to have eluded the NGSS authors. Instead, they conferred primacy on practices and paid too little attention to the knowledge base that makes those practices both feasible and worthwhile. . . . Unfortunately, the NGSS suffer from the belief—widespread among educators—that practices are more important than content. Consequently, every standard in NGSS articulates a practice first, even when doing so obscures the content that students should learn. (Finn & Porter-Magee, 2013, pp. 11–12)

Although Fordham questioned the emphasis of practices in the NGSS, David L. Evans, executive director of NSTA, rebutted the assertion that practices overshadowed content in the NGSS, calling this appraisal a "false dichotomy" (quoted in Robelen, 2013b). However, this was not the reviewers' only concern about the NGSS.

In addition to the standards' focus on practices, Fordham president Chester Finn and Kathleen Porter-Magee (2013) expressed three further grievances with the NGSS:

> First, missing and "implicit" content. . . . [The NGSS] never explicitly requires some content in early grades that is then assumed in subsequent standards. . . . Second, the risk posed by including "assessment boundaries" along with the standards. These are meant to cap large-scale assessments—to put a ceiling on the content and skills that will be measured at each grade—not to limit curriculum or instruction. The likely reality, however, is that such assessment limits will needlessly constrain what is taught and learned, particularly in advanced classrooms and for high-achieving pupils. . . . Third, the failure to include essential math content that is critical to science learning. . . . There is virtually no mathematics, even at the high school level, where it is essential to the learning of physics and chemistry. Rather, the standards seem to assiduously dodge the mathematical demands inherent in the subjects covered. There is math available in the Common Core that could be used to enhance the science of the NGSS. No advantage is taken of this. (pp. 8–9)

These additional three issues, coupled with the organization's belief that the NGSS overemphasized practices in lieu of content, ultimately earned the NGSS a grade of C (Finn & Porter-Magee, 2013).

When considering Fordham's C rating, however, it is important to consider Fordham's other reviews of individual states' science standard documents: "Twenty-six state science standards received grades of D or F from [Fordham] reviewers, while twelve also earned Cs. . . . Only seven earned grades in the A range" (Finn & Porter-Magee, 2013, p. 2). When viewed in this context, the NGSS still fared better than about half of the other state standards in Fordham's rankings. However, Fordham's review of the NGSS still stands as unfavorable when considering that Fordham identified fifteen states with "clearly superior" (Finn & Porter-Magee, 2013, p. 2) science standards in the same report.

Adoption and Implementation of the NGSS

It is important to note that the adoption and implementation phase of the NGSS initiative is still in progress. Ultimately, "the decision to adopt the standards and make them consistent between states lies in the hands of the states themselves" (Achieve, n.d.a). As of April 2015, the following thirteen states had adopted the NGSS (listed chronologically in order of their adoption; Academic Benchmarks, 2015):

1. Rhode Island
2. Kentucky
3. Kansas
4. Maryland
5. Vermont
6. California
7. Delaware
8. Washington
9. Nevada
10. Oregon
11. Illinois
12. New Jersey
13. West Virginia

In addition to these states, the District of Columbia officially adopted the NGSS as well. Some have forecasted that the number of adopting states will eventually "reach the mid-30s or higher" (Robelen, 2013a). Still, the number seems rather modest in comparison to the forty-five states that adopted the CCSS in ELA, mathematics, or both. Besides the previously discussed criticisms, there were at least three reasons for this: (1) legislative restrictions, (2) lack of financial incentives, and (3) lack of time and resources.

First, some states were unable to adopt new science standards due to legislative restrictions. One example is Minnesota, an NGSS lead state, in which state law prohibited the updating of science standards until 2017 (Robelen, 2013a). Additionally, there was "no prior commitment from multiple states to adopt" (NRC, 2012, p. 19) the NGSS during the development phase, which differed from the CCSS initiative in which multiple states made commitments to use the standards before they were published.

Second, unlike the CCSS, there was little financial incentive for states to adopt the NGSS. Marzano and colleagues explained that "the federal government *strongly* encouraged states to adopt the CCSS by making it one of the factors that determined the success of their applications" (2013, p. 7) for Race to the Top, a contest in which states competed for funding from the U.S. Department of Education. As Robelen (2013a) observed, "states that moved fast enough in backing the common core in 2010 stood a better chance of winning" a Race to the Top grant, but no such incentive was offered for adopting the NGSS.

Finally, and perhaps most importantly, implementing new standards takes time and resources, particularly when considering factors such as teacher education, professional development, curricular materials, and assessment (Camins, 2013). This fact prompted many state leaders and standards organizers to encourage a "go-slow approach" to adopting the NGSS (Robelen, 2013d). For example, the NSTA Board of Directors (2013) recognized that teachers would have to make significant instructional shifts in order to use the new standards effectively:

> To support the implementation of the NGSS, teachers are required to demonstrate the ability to master the science and engineering content in the NGSS at the grade level/band they teach; integrate the three dimensions of science and engineering practices, disciplinary core ideas, and crosscutting concepts in instruction and classroom assessment, instead of teaching them separately; organize, maintain, and use instructional materials in student investigations in a safe and effective manner; facilitate appropriate and effective discourse and argumentation with and among students; integrate engineering design concepts into science instruction; collaborate with mathematics and English language arts teachers to capitalize on the recommendations in the NGSS [for] connection to Common Core State Standards; assess and monitor student movement along the progressions within a year or course and over the entire K–12 experience; and provide support and remediation for those students falling behind in their achievement of the expected progression and additional challenges for students who are ready to move ahead in the progression.

Besides these instructional shifts, adoption of the NGSS also brought into question how to assess student performance on the standards once implemented. In the Common Core initiative, states collaborated to create assessments that are aligned to the CCSS (Marzano et al., 2013). As Erik W. Robelen (2013b) explained, one difficulty of creating a similar set of shared assessments for the NGSS is the lack of financial support:

> One challenge is paying for such assessment development. The federal government provided some $360 million in Race to the Top aid to fuel the work of two state testing consortia in crafting common assessments for math and literacy. No such funding appears imminent for the science standards.

However, even without financial constraints, creation of an assessment tailored to the NGSS still proved difficult, specifically because of the unique nature of the standards. For example, because the NGSS stressed the importance of learning science through *doing* science, traditional standardized tests would likely not suffice as an assessment tool. As Camins (2013) asserted:

> The framework and the . . . science standards rest on solid research in the learning sciences, but we still need time and space for evidence-based testing and revision. To reach their potential, we will need finely tuned assessments that provide strong actionable evidence for multiple purposes. . . . No single test format will serve all of these varied constituencies [e.g., teachers, states, instructional-materials developers, researchers] well. Consequential testing, especially in its cheap, easily scored format, will undermine all of these purposes. Myriad unfortunate examples in medical research, finance, and education should make us step back from the pressure for quick results at the risk of compromising integrity.

Robelen (2012a) summarized: "A key goal is to promote more 'authentic' assessments that are able to measure not simply knowledge but also students' ability to apply that learning through the scientific practices identified." Until educators develop these assessments and address other roadblocks, states will most probably continue to move slowly toward adoption and implementation of the NGSS.

Summary

This online resource discussed distinguishing features, the reception, and the adoption and implementation of the Next Generation Science Standards. We briefly reviewed the integration of content and practices, the smaller number of topics, the coherent learning progression, the alignment to the CCSS, and the focus on engineering as unique features of the NGSS. We examined the support and criticism the NGSS received after their release and, more specifically, examined the debate surrounding the document's inclusion of global climate change and evolution. Finally, we presented a list of states that have already adopted and implemented the NGSS and touched on reasons why other states seem hesitant to adopt the NGSS. For further information about the NGSS, please see the companion publication to this document, *Proficiency Scales for the New Science Standards* (Marzano & Yanoski, 2015). The book also provides proficiency scales designed to help teachers implement the NGSS in their classrooms and to guide classroom instruction and assessment.

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