

Data Use in the Next Generation Science Standards

Kim Kastens, Ruth Krumhansl & Leana Nordstrom
Executive Summary

Today’s students will graduate into a world where oceans of data are available to influence and drive decision making. When the Oceans of Data Institute (<http://oceansofdata.org>) surveyed 300+ students from community college and university settings, 85% of respondents agreed or strongly agreed that the ability to make sense of data is important to get a good job and will help in their future careers. An overwhelming 90% of respondents agreed or strongly agreed that learning to make sense of data will help them be more effective and informed citizens. But how well are we preparing them for this data-driven future?

The *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013), if broadly implemented, have the potential to define science education in coming decades. To assess the potential future use of data in the classroom, ODI analyzed these standards to

- document the abundance of data-using in the NGSS.
- explore the distribution of data-using in the NGSS across grade bands and disciplines.
- begin to assess how well the data-using skills called for in the NGSS align with the tasks and duties performed by big-data-enabled specialists in today’s workforce.

Data-using in the NGSS

The NGSS is made up of 206 performance expectations (PEs), which “are the assessable statements of what students should know and be able to do” at certain grade levels. Each performance expectation incorporates a disciplinary core idea from the physical sciences, life sciences, earth/space sciences, or engineering/technology; a scientific or engineering practice (e.g., asking questions and defining problems, analyzing and interpreting data); and in some cases a cross-cutting concept (e.g., patterns, cause and effect, scale).

This white paper analyzes the quantity and nature of NGSS PEs that involve the use of data. This includes

- PEs that specifically include *Practice #4: Analyzing and interpreting data*; and
- PEs in which the use of data is implicit within other practices, such as *Practice #7: Engaging in argument with evidence*, *Practice #3: Planning & carrying out investigations*, and *Practice #5: Using mathematics and computational thinking*.

On average, 12% of the PEs in the NGSS specifically cite *Practice #4: Analyzing and interpreting data*. Across grades, the percentage of PEs citing this practice are highest in elementary (13%) and middle school (15%), and drop off significantly in high school (7%). Across disciplines, Earth & Space Sciences is richest in opportunities to employ *Practice #4*: 16% of the Earth/Space PEs cite *Practice #4*, as opposed to 14% of the Engineering/ Technology PEs, 13% of those in Life Sciences and only 7% of those in Physical Sciences.

Analyses of PEs not specifically citing *Practice #4* indicate that data-use is in many cases referenced or implied. For example, *Practice #7: Engaging in argument from evidence* indicates that students should “support an argument with evidence, **data**, or a model.” When such PEs are considered, along with those specifically citing *Practice #4: Analyzing and interpreting data*, the percentage of PEs that involve data-using skills in K–12 increases significantly to 46%, and it is more evenly distributed across grade bands (46% in elementary, 49% in middle school, and 43% in high school).

Alignment of NGSS with tasks and duties performed by big-data-enabled specialists

In 2014, ODI convened a panel of experts who use big data in a variety of applications. These experts ranged from a principal data scientist at Bing/Microsoft to a crime analyst in a police department. ODI worked with these experts during a two-day intensive workshop to develop an occupational profile of the big-data-enabled specialist (BDES). Our facilitation protocol, which is based in part on the Developing a Curriculum (DACUM) occupational analysis model, rests upon three basic principles:

- Expert workers can describe and define their jobs more accurately than anyone else.
- An effective way to define a job is to precisely describe the tasks that expert workers perform.
- All tasks, to be performed correctly, demand certain knowledge, skills, resources, and behaviors.

The profile emerging from the workshop was then validated by 150+ BDESs, representing a broad range of industry sectors—ranging from organizations such as IBM and Facebook to Airbnb and the Dana Farber Cancer Institute. The resulting profile is a unique mapping of the skills, knowledge, behaviors, resources, duties, and tasks that big data specialists engage with to be successful in their careers, across industries.

To explore how well NGSS-aligned curricula could prepare students to participate in a big data economy, ODI compared the NGSS PEs with the tasks listed in the BDES occupational profile.

There appears to be strong alignment between many of the duties and tasks articulated in the BDES profile and the NGSS PEs. Areas of strong alignment include:

- the profile’s *Tasks 1C: Articulates question, 1E: Translates question into research plan, and 1F: Designs experiments* are well aligned with PEs incorporating NGSS *Practice #2: Asking questions and defining problems* and *Practice #3: Planning and carrying out investigations*.
- The profile’s *Tasks 5A: Develops analysis plan, 5B: Applies methods and tools, and 5D: Evaluates results of the analysis* are all aligned with NGSS *Practice #4: Analyzing and interpreting data*.
- The profile’s *Task 6I: Contrasts alternative approaches and past results* is aligned with NGSS *Practice #8: Obtaining, evaluating, and communicating findings*.

Other aspects of big data science are poorly represented in the NGSS, notably tasks related to data management, data quality, and data ethics.

The above examples of alignment between the NGSS and the duties and tasks performed by BDESs are not surprising, since the use of data is at the core of scientific and engineering work. In the K–12 system, science classrooms are an ideal place to develop the skills that will be essential to make evidence-based decisions in an increasingly data-infused society. More work is needed to “unpack” the tasks listed in the BDES profile, better understand the foundational skills that undergird the ability to work with “big” data, and advance instruction from today’s *status quo* towards NGSS-aligned teaching and learning. However, the strong emphasis on the use of data in the NGSS is good news and should help to propel the transformation necessary to prepare today’s students for tomorrow’s world.